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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

FRACTAL GROWTH OF VISCOUS FINGERS: QUANTITATIVE CHARACTERIZATION OF A FLUID INSTABILITY PHENOMENON,
Dowell Schlumberger Research and Development, Saint-Etienne (France).
For primary bibliographic entry see Field 1B.
W85-05854

1B. Aqueous Solutions and Suspensions

FRACTAL GROWTH OF VISCOUS FINGERS: QUANTITATIVE CHARACTERIZATION OF A FLUID INSTABILITY PHENOMENON,
Dowell Schlumberger Research and Development, Saint-Etienne (France).
J. Nittmann, G. Daccord, and H. E. Stanley.
Nature, Vol. 314, No. 6007, p 141-144, March 14-20, 1985. 7 Fig, 26 Ref.

Descriptors: *Water properties, *Fluid instability, *Viscosity, *Fractal geometry, Physical properties, Hele-Shaw cells.

When a low viscosity fluid like water is used to push a high viscosity fluid like oil, there arises a fluid instability phenomenon termed the 'viscous fingering instability' in which the low viscosity fluid forms characteristic fingers extending well into the high viscosity fluid. Water, dyed with methylene blue, was used to push a more viscous but miscible, non-newtonian fluid in a Hele-Shaw cell which is a pair of transparent plates separated by 0.5 mm. The viscous fluid used was an aqueous polymer solution of high relative molecular mass polysaccharide for which the mixing time is very slow compared with the time of the experiment. The resulting viscous finger instability was found to be a fractal growth phenomenon. Reproducible values of the fractal dimension d sub f were found and were interpreted using a modification of the diffusion limited aggregation model. The physical basis of the viscous fingering instability is analagous to that of other second-order phase transitions that obey the same sort of scale invariant symmetry found here for viscous fingers. (Collier-IVI)
W85-05854

2. WATER CYCLE

2A. General

INFLUENCES OF PRECIPITATION CHANGES AND DIRECT CO2 EFFECTS ON STREAMFLOW,
University of East Anglia, Norwich (England). Climatic Research Unit.
T. M. L. Wigley, and P. D. Jones.
Nature, Vol. 314, No. 6007, p 149-152, March, 1985. 2 Fig, 1 Tab, 15 Ref.

Descriptors: *Carbon dioxide, *Hydrologic cycle, *Precipitation, *Climatology, *Streamflow, Plant physiology, Evapotranspiration, Atmosphere.

Increasing atmospheric carbon dioxide concentrations are expected to cause major changes in the world's climate over the next 50-100 yr. The impact of such changes on water resources, through changing precipitation and evaporation, will, however, be complicated by the direct effects of increasing CO2 on vegetation. In controlled environment experiments, higher CO2 levels cause the stomata of plants to close down, decreasing their rate of transpiration and increasing their water use efficiency. Reduced evapotranspiration would make more water available as runoff and could tend to offset the effects of any CO2-induced reductions in precipitation or enhance the effects of precipitation increases. The relative sensitivity of runoff to changes in precipitation and changes in evapotranspiration was analyzed. For low runoff ratios, small changes in precipitation may cause large changes in runoff. The magnitude and direction of these changes is, however, strongly dependent on the magnitude of the direct CO2 effect on plant evapotranspiration. (Author's abstract)
W85-05855

CONCEPTUAL MODEL OF UNIT-MASS RESPONSE FUNCTION FOR NONPOINT SOURCE POLLUTANT RUNOFF,
Padua Univ. (Italy). Faculty of Engineering.
For primary bibliographic entry see Field 5B.
W85-05872

PREDICTING THE MEAN ANNUAL FLOOD FROM BASIN CHARACTERISTICS IN SCOTLAND,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W85-05902

REGIONAL FLOOD FREQUENCY ESTIMATION USING THE TWO-COMPONENT EXTREME VALUE DISTRIBUTION,
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
M. Fiorentino, P. Versace, and F. Rossi.
Hydrological Sciences Journal, Vol. 30, No. 1, p 51-64, March, 1985. 8 Fig, 9 Ref.

Descriptors: *Regional flood frequency, *Flood frequency, *Statistical analysis, *Model studies, Regional floods, Hydrologic models, Regionalization.

The two-component extreme value (TCEV) distributions, suggested for modelling Italian annual flood series (AFS), was shown to account both for the presence of flow outliers and for the high variability of the skewness of historical AFSs. Using such a model, the T-year flood was found to vary with log(T) much more rapidly for large values of T than is the case for small values of T. The presence of four parameters in the TCEV distribution introduces great uncertainty in estimating the T-year flood when the parameters are estimated from a single series. Regional analysis, which exploits basin similarities, is then needed, not only at ungauged sites but also at gauged ones. Combined regionalization techniques, by which all flood data over a region produce a single regional flood distribution, are described and their application to Italian data is shown. (Author's abstract)
W85-05903

HYDROLOGICAL REGIONALIZATION OF SWEDEN,
Oslo Univ. (Norway). Inst. of Geophysics.
L. Gottschalk.
Hydrological Sciences Journal, Vol. 30, No. 1, p 65-83, March, 1985. 6 Fig, 5 Tab, 28 Ref.

Descriptors: *Regionalization, *Sweden, *Hydrologic models, Statistical analysis, Principle component analysis, Runoff, Physiographic provinces.

Hydrological regionalization is an important tool for the analysis of the spatial pattern of variations in hydrological phenomena. Regionalization means areal classification, i.e. the ability to attach to some location a label or number which is hydrologically meaningful. With the use of statistical methods, hydrological regions are analogous to areal classes. Pairwise grouping as well as principal components were applied to Swedish river runoff data in order to analyze the patterns of variation and to delimit regions where hydrological behavior may be regarded as uniform. Pairwise grouping is the appropriate method to use on a national scale with heterogeneous hydrological regimes. Principal components (empirical orthogonal functions) demand homogeneity but within such regions describe very well the trends and variations. (Author's abstract)
W85-05904

HYDROLOGIC BEHAVIOUR OF A SMALL FORESTED CATCHMENT,
Melbourne Univ., Parkville (Australia). Forestry Section.
L. J. Bren, and A. K. Turner.
Journal of Hydrology, Vol. 76, No. 3/4, p 333-350, February, 1985. 15 Fig, 1 Tab, 12 Ref.

Descriptors: *Hydrologic models, *Catchments, *Forest hydrology, *Australia, Groundwater, Flow, Boussinesq equation, Mathematical equation, Streamflow, Springs, Storm seepage, Groundwater movement.

The variations in discharge along a reach of stream emanating from a spring at the head of a small steep forested catchment in southeastern Australia were measured over a 4 yr period. The outflow of the springhead catchment was considerably less variable than the outflow of the catchment flanks along the length of the stream. Following substantial periods of rainfall the peak discharges from the springhead were reached some days after the cessation of rain, while the peak discharges from the flank catchment were reached during or immediately after the period of rainfall. Diurnal variations in summer streamflows were not observed at the springhead, but were observed with an increasing amplitude as distance downstream from the springhead increased. Field studies and mathematical analysis indicated that neither overland flow nor channel interception of rainfall were important in generating the streamflow response to any but very small storms, and that groundwater movement within a phreatic aquifer was the dominant process at all times. The hydraulic gradient of the groundwater was considerably steeper than generally attributed to such systems. To aid in interpretation, numerical solutions of the Boussinesq equation were used cast in a coordinate system approximating that of the component catchments. These showed that the observations are explainable as the effect of catchment shape on groundwater outflow. A noted perturbation in recession hydrographs may be attributable to the presence of a symmetry boundary associated with the ridge. (Baker-IVI)
W85-06052

RESOLVING THIESSEN POLYGONS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
T. E. Croley, II, and H. C. Hartmann.
Journal of Hydrology, Vol. 76, No. 3/4, p 363-379, February, 1985. 5 Fig, 18 Ref.

Descriptors: *Lake Superior, *Forecasting, *Thiessen polygons, *Computers, Data processing, Flows, Meteorological data, Water level, Runoff.

An automatic computer forecast package for Lake Superior, North America has been developed that uses near real-time meteorological data to produce operational outlooks of basin runoff for improving lake level regulations. The data collection network changes frequently as stations are added or dropped or fail to report from time to time. Therefore, forecasts depend on semi-automatic updating of meteorological data, requiring efficient computations of Thiessen weights. Various methods of computing Thiessen weights either have large computational overheads or provide unacceptable approximations. A polygon-edge-definition algorithm is described which rapidly determines Thiessen weights by using a digital map. Since relatively few of the points in the digital map are actually looked at to determine polygon boundaries, the procedure is much faster than exhaustive search methods that compute the closest station for every point in the map. It is also more accurate than sampling methods that only approximate Theissen weights by computing the closest station for a limited number of sampled points. It also allows the use of efficient bit maps for single-basin applications. The edge-definition procedure is especially advantageous for high-resolution maps of watershed areas, even with extremely high density data observation networks. The method has far reaching applications including areal averages of meteorologic variables, lake-level estimation, groundwater level estimation, near real time accounting of network changes, computer map generation and

realtime graphics, and even industrial engineering applications in computer aided description of convex shapes. (Baker-IVI)
W85-06054

ASSESSMENT OF NON-STATIONARITY IN ANNUAL SERIES THROUGH EVOLUTIONARY SPECTRA,
Birmingham Univ. (England). Dept. of Civil Engineering.
N. T. Kottegoda.
Journal of Hydrology, Vol. 76, No. 3/4, p 381-402, February, 1985. 9 Fig, 1 Tab, 25 Ref.

Descriptors: *Non-stationarity, *Time series analysis, *Evaluation, *Streamflow forecasting, Hydrologic models, Auto-regressive moving average, Simulation, Stream flow, Precipitation.

Different forms of non-stationary behavior may be evident in the analysis of natural time series. Non-stationary series can be viewed as ones that are being disturbed by transient effects of one or more kinds with different causative factors. An index method of evaluating non-stationary behavior is proposed. Auto-regressive moving average (ARMA) models are initially fitted to annual hydrologic time series. Evolutionary spectra are estimated from overlapping sub-samples formed from a sequence of observations. Chi-squared variables are obtained over a high frequency band of the spectrum and standardized by means of the theoretical median value of chi-squared to form a K index. Empirical distribution for K are calculated from stationary series simulated using the same model structures and sequence lengths as in the historical sets. The time series of K formed from overlapping sections, in relation to its median value and extreme percentiles provides a measure of non-stationarity. Eleven annual flow, precipitation and a tree ring series from nothern Utah and the Nile flows at Aswan dam, Egypt, are investigated. The proposed method should help in estimating the time horizons over which stationarity is a reasonable assumption and the resilience which needs to be provided in planning future schemes. (Baker-IVI)
W85-06055

2B. Precipitation

INFLUENCES OF PRECIPITATION CHANGES AND DIRECT CO2 EFFECTS ON STREAMFLOW,
University of East Anglia, Norwich (England). Climatic Research Unit.
For primary bibliographic entry see Field 2A.
W85-05855

APPORTIONMENT OF RAINFALL IN CENTRAL HIMALAYAN FORESTS (INDIA),
Banaras Hindu Univ., Varanasi (India). Dept. of Botany.
P. C. Pathak, A. N. Pandey, and J. S. Singh.
Journal of Hydrology, Vol. 76, No. 3/4, p 319-332, February, 1985. 3 Fig, 4 Tab, 34 Ref.

Descriptors: *Rainfall, *Forest watersheds, *Interception, *Kumaun Himalaya, *India, Runoff, Infiltration, Overland flow, Stemflow, Throughfall, Canopy, Monsoons, Base flow.

The apportionment of rainfall into throughfall, stemflow and interception in certain forests of Kumaun Himalaya was assessed during the 1981 and 1982 monsoon seasons. The percentage of incident rainfall reaching the forest floor through the canopy ranged between 72% and 83%. The interspecies differences were significant. A larger shower size accompanied by higher intensity resulted in greater stand throughfall. Stand throughfall as percent of incident rainfall plateaued and became almost constant for larger rainshowers. A lower intensity during a larger shower reduced the throughfall in proportion to rainfall quantity. Observation also indicated that a greater quantity of throughfall arrived on the floor during a rainfall of moderate size and intensity, provided the canopy was saturated by the preceding rainfall event. The proportion of gross rainfall reaching the ground as stand throughfall was maximum (91.5%) on the pine mixed broadleaf forest site and least on the pine forest site (74.7%). No stemflow occurred when the shower size was less than 2.2 mm. Stand stemflow accounted for only a small percent of gross rainfall. Comparison of regression slopes in the given equations indicates that the pine-mixed broadleaf forest is different from all other forests. Canopy interception varied among species from 14.3% to 28% of gross rainfall. Rain water falling on the litter gradually increases the litter moisture level to field capacity and then to saturation. The litter layer in the present forests intercepted a greater percent of gross rainfall when the shower size was small. The litter layer did not intercept as much rainfall as did the canopy. Interception of rainfall by litter was greater in broadleaf forests compared to pine and pine-dominated forests. Overland flow did not normally occur if the shower size was less than 10 mm. Low surface runoff values in this study suggest that the slopes are highly infiltrating and water transmission is more baseflow dominated. (Baker-IVI)
W85-06051

ANNUAL AND MONTHLY PRECIPITATION GENERATION IN IDAHO,
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
C. L. Hanson.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1792-1797 and 1804, November-December, 1984. 3 Fig, 8 Tab, 9 Ref.

Descriptors: *Precipitation, *Idaho, *Statistical analysis, Monthly distribution, Annual distribution, Rainfall distribution.

Procedures were developed which can be used to generate synthetic annual and monthly precipitation series for locations in Idaho. Analyses of records from Idaho stations and stations adjoining Idaho indicate that the normal distribution is more representative of the annual series for locations in the intermountain region of the Pacific Northwest than the log-normal distribution that has been suggested for other areas of the United States. The normal distribution was used to generate annual series and the cube-root-normal distribution is used to generate monthly series. The monthly procedure includes a method for generating zero monthly amounts in the series. The uniform distribution was used to determine if a value in the series being generated is zero. As with the annual generating procedure, only the mean monthly amount is necessary because linear relationships are given to calculate the standard deviation from the mean precipitation amount. Mean and standard deviation of the cube-root transformed series were calculated so that the normal distribution can be used to generate synthetic monthly series. (Collier-IVI)
W85-06089

2D. Evaporation and Transpiration

MODIFICATION OF IRRIGATION REQUIREMENT OF WHEAT THROUGH MULCHING AND FOLIAR APPLICATION OF TRANSPIRATION SUPPRESSANTS,
Indian Agricultural Research Inst., New Delhi. Div. of Agronomy.
For primary bibliographic entry see Field 3F.
W85-05923

COMPARISON OF METHODS USED TO ESTIMATE EVAPOTRANSPIRATION FOR LEACHING CONTROL,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 7B.
W85-05926

DIURNAL CHANGES IN THE WATER RELATIONS AND TRANSPIRATION OF A SOYBEAN CROP SIMULATED DURING THE DEVELOPMENT OF WATER DEFICITS,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 2I.
W85-05932

QUANTITATIVE APPROACH TO THE PRUITT AND DOORENBOS VERSION OF THE PENMAN EQUATION,
Nebraska Univ. Panhandle State at Scottsbluff.
A. Weiss.
Irrigation Science, Vol. 4, No. 4, p 267-275, December, 1983. 3 Fig, 1 Tab, 32 Ref. OWRT project A-064-NEB.

Descriptors: *Penman Equation, *Evapotranspiration, *Alfalfa, Wind, Humidity, Reference crop evapotranspiration, Mathematical equations.

Since its development, the Penman equation has been widely used to calculate reference crop evapotranspiration. The Pruitt and Doorenbos version of the Penman equation is calculated mainly from tables and is based on measurements made over a grass surface. The tabular procedures are quantified, and the approach is extended to measurements made over alfalfa. The latter was achieved by using a wind function that takes into account the height of the alfalfa and the use of mean rather than maximum relative humidity to calculate the correction factor used to take into account day and night weather conditions on calculated reference crop evapotranspiration. Calculated values of evapotranspiration overestimated measured values from alfalfa by 13%. A much better agreement was obtained between these general procedures and a Penman equation with a locally derived wind function from data collected with an automated weather station. The procudures can be extended to the calculation of daily reference crop evapotranspiration values rather than 10 or 30 day mean values. (Moore-IVI)
W85-05936

EVAPOTRANSPIRATION AND WATER USE EFFICIENCY OF TARO,
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
S. F. Shih, and G. H. Snyder.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1745-1748, November-December, 1984. 2 Fig, 1 Tab, 8 Ref. South Florida Water Management District grant 4-FCD-22.

Descriptors: *Evapotranspiration, *Water use efficiency, *Taro, *Crop production, *Everglades Agricultural Area, *Florida, Wetlands, Biomass, Subsidence.

Production of taro in the Everglades Agricultural Area would help in reducing organic soil subsidence because this crop can be kept flooded like rice. Objectives of this study were to study the ET requirement and water use efficiency for taro production and to establish relationships between ET and taro yield. Evapotranspiration (ET) and water use efficiency were determined from lysimeters installed within a taro field. The ET from taro varied from 2.0 to 6.5 mm/day. About 3000 to 4300 kg of water was required to produce 1 kg of dry biomass (DB), and the water required to produce 1 kg of tuber yield (TY) ranged from 1400 to 1900 kg. The relationship between DB and ET was found to be DB = -27.7 + 25.8(0.001)ET (r squared = 0.95) and the TY was related to ET as TY = -60.5 + 56.3(0.001)ET (r squared = 0.92), where the units of yields and ET are t/ha and mm, respectively. Dry biomass is not only highly correlated to the ET but is also a better predictor for estimating the ET required for taro production than the tuber yield. (Collier-IVI)
W85-06081

2E. Streamflow and Runoff

BIFURCATIONS OF FINNISH WATERCOURSES (SUOMEN VESISTOJEN BIFURKAATIOT),
National Board of Waters, Helsinki (Finland). Hy-

drological Office.
E. Kuusisto.
Terra, Vol. 96, No. 4, p 253-261, 1984. 8 Fig, 7 Ref.

Descriptors: *Streambeds, *Channels, *Bifurcation, *Finland, Basins, Lakes, Channel morphology.

About 40 lake and 25 river bifurcations in Finland are described in this article. According to their location, the bifurcations can be classified to external and internal bifurcations. An external bifurcation is located on the divide, either between two river basins or between two subbasins. An internal bifurcation occurs within a river basin or subbasin. The branches of an internal bifurcation have a junction downstream; if at least one branch has a tributary before the junction, the bifurcation is an ordinary internal bifurcation. If the discharge in both branches remains unchanged, the branching is called pseudobifurcation. Some of the bifurcations are temporary; 14 lakes and 16 river bifurcations can be considered perennial. Some of lake bifurcations and about half of river bifurcations are manmade. A few important bifurcations are described in some detail. Three major lakes are bifurcating perennially to different river basins: Lake Muojarvi (area 56 sq km) in Kuusamo and Lakes Lummene and Vesijako in Hame. The most important river bifurcation is located in Junosuando, where part of the waters of River Tornionjoki flow into River Kalixalven. (Author's abstract)
W85-05856

FACTORS AFFECTING CHOICE OF DISTRIBUTION FOR FLOOD SERIES,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
C. Cunnane.
Hydrological Sciences Journal, Vol. 30, No. 1, p 25-36, March, 1985. 3 Fig, 42 Ref.

Descriptors: *Flood series, *Annual floods, *Distribution analysis, Flood peak, Data interpretation, Hydrology, Statistical analysis.

In flood frequency analysis a basic assumption is that a series of flood peaks is a random sample from a stationary population; however, one can never be completely sure that this assumption is true. Rival candidate distributions for modelling flood series may give markedly different magnitude-return period (Q-T) relationships, particularly at high T. A priori theoretical arguments for choice of distribution do not provide a satisfactory answer and the arguments that have been put forward are of doubtful validity. Distribution choice cannot be made on theoretical arguments alone. Observed annual maximum (AM) data display positive skewness and large kurtosis and the skewness is more variable between AM samples than between similar sized random samples from all but one previously used flood distribution. Inference must be based on many sets of flow data simultaneously. Traditional goodness of fit tests are insensitive to distribution tail behavior, which is of most importance hydrologically. Dimensionless sample moments are biased downwards and use of moment-ratio diagrams, without allowance for moment bias, must lead to erroneous inference. The necessity for log and other data transformations in flood frequency analysis is questioned as is the arbitrary use of mixtures of distributions without physical justification. (Collier-IVI)
W85-05901

PREDICTING THE MEAN ANNUAL FLOOD FROM BASIN CHARACTERISTICS IN SCOTLAND,
Institute of Hydrology, Wallingford (England).
M. C. Acreman.
Hydrological Sciences Journal, Vol. 30, No. 1, p 37-49, March, 1985. 2 Fig, 1 Tab, 28 Ref.

Descriptors: *Scotland, *Annual floods, *Basins, *Hydrologic models, *Prediction, Model studies, Rainfall, Soil type, Lakes, Statistical analysis.

Flood data were assembled for 168 Scottish basins containing 3071 station-years of record. Multiple regression techniques were used to produce equations for predicting mean annual flood from physiographic and climatological basin characteristics. Mean annual rainfall (SAAR) gave better results than measures of extreme rainfall (M52D and RSMD). Percentage area of lake storage (LOCH) was found to be a better predictor than fraction of the basin draining through a lake (LAKE). Apart from SAAR and LOCH, the recommended equation requires the basin area (AREA), stream frequency (STMFRQ) and an index of the soil type (SOIL). Measures of average basin slope (AVES) and main stream slope (S1085) were not statistically significant. The standard error of the estimate of the predicted mean annual flood is 0.147. The equation has a coefficient of determination, R-squared, of 0.914 and appears robust over a wide range of basin types without requiring regionally derived multipliers or coefficients. No significant improvement in fit was achieved by ridge regression, Stein estimation or use of the influence function. (Author's abstract)
W85-05902

REGIONAL FLOOD FREQUENCY ESTIMATION USING THE TWO-COMPONENT EXTREME VALUE DISTRIBUTION,
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
For primary bibliographic entry see Field 2A.
W85-05903

APPRAISAL OF THE REGIONAL FLOOD FREQUENCY PROCEDURE IN THE UK FLOOD STUDIES REPORT,
Institute of Hydrology, Wallingford (England).
J. R. M. Hosking, J. R. Wallis, and E. F. Wood.
Hydrological Sciences Journal, Vol. 30. No. 1, p 85-109, March, 1985. 11 Fig, 6 Tab, 17 Ref, 1 Append.

Descriptors: *Flood frequency, *Algorithms, *United Kingdom, Computers, Simulation, Monte Carlo method, Estimation.

Upper quantile estimates that appear unrealistic (compared with engineering judgement) may result from use of the Natural Environment Research Council (London) 1975 Flood Studies Report (FSR) algorithm for estimating the regional flood frequency hazard. An automated computer based version of the FSR algorithm was developed and modified so as to be useable as a subroutine in a computer-based Monte Carlo study. Tests with the FSR algorithm were made for observed flood sequences and synthetic data in a Monte Carlo simulation study. Similar tests were conducted with many other regional and at-site flood frequency estimation procedures including a regional generalized extreme value distribution (GEV) procedure and a regional Wakeby distribution (WAK) procedure, both of which used biased probability weighted moments (PWM) in their formulation. For the Monte Carlo simulations, for which the true quantiles to be estimated were known, the FSR algorithm yielded quantile estimates that were always more variable, often by a factor of as much as 4 or 5, than those obtained by either the GEV/PWM or WAK/PWM algorithms. The FSR algorithm yielded quantile estimates that were nearly always more biased than those obtainable by either the GEV/PWM or the WAK/PWM procedures. The use of the FSR algorithm with small data bases, short records, or in regions of high coefficient of variation, or in the presence of outliers in the flood sequences, leads to results that are relatively unreliable when compared with those obtainable by other methods. Analysis of a larger data base than originally used for the preparation of the FSR using the GEV/PWM algorithm may well lead to more accurate and more consistent estimation of the extremal flood hazard for the United Kingdom. (Moore-IVI)
W85-05905

PROBABILITY DISTRIBUTIONS OF ANNUAL MAXIMA OF SEASONAL HYDROLOGICAL VARIABLES,
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
P. Lamberti, and S. Pilati.
Hydrological Sciences Journal, Vol. 30, No. 1, p 111-135, March, 1985. 15 Fig, 6 Tab, 10 Ref. Italian Council of National Research contract 821881.

Descriptors: *Seasonal variation, *Flood discharge, *Probability distribution, *Italy, Flow discharge, Statistical studies, River flow, River forecasting, Flood forecasting.

The influence of 'seasonality' on the distribution of maxima of a hydrological variable was studied theoretically and using data on actual flood discharges. The flood discharges of three rivers in the Po basin of Italy, with different 'seasonalities', were analyzed. Three different types of monthly maxima cumulative distribution function (CDF) were selected: Gumbel, GEV, and an exponential type. The shape of the distribution function of annual extremes is not related to that of the seasonal components which determine it. In particular it is not stable (extreme values asymptotic distribution) even if the components are stable. The analysis of seasonal maxima does not seem to be useful for increasing the reliability of estimates of rare events. The observations available in addition to the the annual maxima, are, by their nature, found mostly in the range of small discharges. These additional observations produce more noise than information and often cause notable errors even in the range of the largest discharges observed. When the maxima of a single season are of concern, it is advisable to also use data pertaining to the other season in which discharges close to those of interest have been observed. (Moore-IVI)
W85-05906

LINEAR APPROACH TO THE INFLUENCE OF DISCHARGE MEASUREMENT ERROR ON FLOOD ESTIMATES,
Genoa Univ. (Italy). Inst. of Hydraulics.
R. Rosso.
Hydrological Sciences Journal, Vol. 30, No. 1, p 137-149, March, 1985. 7 Fig, 3 Tab, 15 Ref.

Descriptors: *Error analysis, *Flow discharge, *Flood flow, Statistical analysis, Prediction, Estimation, Probability distribution, Flood peak.

The presence of consistent error in an observed series of discharge measurements of flood flows may seriously affect statistical analysis, introducing additional bias and uncertainties in flood predictions estimated from such data. A linear approach to the influence of random measurement errors on flood estimates is presented in the form of a simple conditional probability model independent of the parent probability distribution of floods. Flood predictions provided by quantiles are positively biased when performed from a sample of discharge observations affected by measurement errors. Though for design purposes such an effect is conservative, this bias cannot be neglected if the peak discharges are determined from stage measurements by means of the extrapolated tail of the rating curve for the gauging station concerned. Monte Carlo experiments, carried out to analyze small sample effects, have shown that the use of the method of maximum likelihood is able to reduce the bias due to measurement errors in discharge data. (Moore-IVI)
W85-05907

GROUPING BASINS FOR REGIONAL FLOOD FREQUENCY ANALYSIS,
Institute of Hydrology, Wallingford (England).
S. E. Wiltshire.
Hydrological Sciences Journal, Vol. 30, No. 1, p 151-159, March, 1985. 4 Fig, 1 Tab, 4 Ref.

Descriptors: *Flood frequency analysis, *Basins, *Regional flood estimation, Estimation, Flood frequency, Rainfall, Soil properties, Catchment basins.

At sites where flood data are limited or absent, engineers may apply a regional flood estimation procedure. The definition of regions may cause difficulties in regional flood estimation; geographical proximity is no guarantee of homogeneity since

neighboring basins can be physically very different. A new method of grouping basins prior to regional flood frequency analysis is presented which is based on measured basin characteristics rather than on geographical regions. The method partitions a set of basins into two groups on the basis of a single partitioning value of one chosen basin characteristic. Average frequency curves are fitted to pooled flood data for each group, and measures of the variability of the data in each group about the fitted group curve are evaluated. The sequence of forming two groups, fitting two frequency curves, and evaluating test statistics is repeated using a range of partition points. The optimum grouping is achieved at the basin characteristic value where the statistics of departure reach a minimum. This process may be repeated for other characteristics for multiple partitions, or indeed for combinations of characteristics. Three groups formed on the basis of soil type and annual rainfall were found to be comparable in efficiency to 10 regions formed on the basis of geographical proximity. (Moore-IVI)
W85-05908

NOMOGRAM FOR VELOCITIES OF PARTIAL FLOWS IN SEWERS,
College of Military Engineering, Poona (India). Dept. of Civil Engineering.
B. R. N. Gupta.
Journal of Environmental Engineering, Vol. 111, No. 2, p 225-230, April, 1985. 1 Fig, 3 Tab.

Descriptors: *Partial flow, *Velocity, *Nomograms, *Sewers, Flow discharge, Slope, Pipelines, Design criteria.

A nomogram is presented to read the velocities of partial flows in sewers quickly, eliminating all the steps and thus saving design time and effort. The new approach presented here is to determine the velocity in sewers for partial flows when the slope and discharge are known. The data on diameter of pipe is somewhat redundant since, in the case of partial flows, the diameter has only limited influence on the velocity for a particular flow and slope of pipe. This assumption is reasonable for design of sewers and the accuracy of results obtained using the above assumption is considered adequate for routine design purposes. A nomogram is developed based on the preceding hydraulic phenomena. The nomogram is based on Mannings equation for flow in sewers. The nomogram can thus save time and labor in solving problems relating to partial flows if depths of flow in sewerage designs do not exceed 0.75 of diameter nor diminish below 0.25 of diameter, which is true in general. Within this range, the assumption holds reasonably well and the chart can be relied upon to give results of fairly reasonable and acceptable accuracies. (Baker-IVI)
W85-06022

EXTENDED STREAMFLOW FORECASTING USING NWSRFS,
National Weather Service, Silver Spring, MD. Hydrologic Research Lab.
G. N. Day.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 157-170, April, 1985. 6 Fig, 2 Tab, 12 Ref.

Descriptors: *Streamflow forecasting, *NWSRFS, *Extended forecasting, Forecasting, Snowmelt, Soil water, Rivers, Reservoirs, Simulation, Hydraulic models, Hydrologic models, Flood forecasting, Probability.

Extended forecasting using the National Weather Service River Forecast System (NWSRFS) is done with the NWS Extended Streamflow Prediction (ESP) program. This paper examines the theory, capabilities, and potential applications of the ESP procedure. ESP uses conceptual hydrologic/hydraulic models to forecast future streamflow using the current snow, soil moisture, river, and reservoir conditions with historical meteorological data. The ESP procedure assumes that meteorological events that occurred in the past are representative of events that may occur in the future. Each year of historical meteorological data is assumed to be a possible representation of the future and is used to simulate a streamflow trace. The simulated streamflow traces can be scanned for maximum flow, minimum flow, volume of flow, reservoir stage, etc., for any period in the future. ESP produces a probabilistic forecast for each streamflow variable and period of interest. The procedure was originally developed for water supply forecasting in snowmelt areas, but it can also be used to produce spring flood outlooks, forecasts for navigation, inflow hydrographs for reservoir operation, and time series needed for risk analysis during droughts. (Author's abstract)
W85-06029

STAGE-FREQUENCY ANALYSIS AT A MAJOR RIVER JUNCTION,
Army Engineer District, St. Louis, MO.
G. R. Dyhouse.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 565-583, April, 1985. 11 Fig, 1 Tab, 7 Ref, 1 Append.

Descriptors: *Stage-frequency analysis, *River junctions, *Illinois River, *Illinois, *Levees, Water surface profiles, Backwater, Flow discharge, Confluent streams, Construction costs, Coincident frequency analysis.

A coincident frequency analysis using the total probability theorem was performed for an 80-mile (129-km) reach of the Illinois River to evaluate existing stage-frequency relationships and revisions caused by a proposed higher levee system. Frequency and duration relationships were derived to establish the upstream and downstream boundaries. A water surface profile model was applied to calculate stage at 210 points in the reach for given starting backwater and discharge conditions. The analytical process was calibrated to stage data in the reach through iterative adjustments in the boundary duration curves. Comparisons of the adopted results to previous analyses using simplified techniques showed a significant reduction in levee design profile and potential cost savings of $1,600,000 in levee construction. (Author's abstract)
W85-06035

KINEMATIC SHOCK: SENSITIVITY ANALYSIS,
San Diego State Univ., CA.
V. M. Ponce, and D. Windingland.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 600-611, April, 1985. 2 Fig, 4 Tab, 12 Ref, 1 Append.

Descriptors: *Kinematic waves, *Sensitivity analysis, *Kinematic shock, Channel morphology, Computer models, Model studies, Froude number, Waves, Hydrographs, Flow, Mathematical models.

Numerical experiments were performed to determine the flow and channel characteristics that are most conducive to kinematic wave steepening and associated kinematic shock phenomena. Relevant flow and channel characteristics were identified at the outset, and a program of 80 computer runs was completed, varying the inflow hydrograph peak Froude number, time-to-peak, and base-to-peak flow ratio, and the channel cross-sectional shape. Standardized channel lengths were calculated to enable the analysis of shocks at comparable stages of development. Gamma hydrograph inflows are routed from upstream to downstream using a physically based flow routing computer model. The inflow hydrograph peak Froude number, time-to-peak, and base-to-peak flow ratio, and the cross-sectional shape parameter all have a definite effect on kinematic shock development. The size of the wave may be most closely related to the occurrence or nonoccurrence of the shock. Kinematic shock will be most likely to occur under the following conditions: a kinematic wave; a low base-to-peak flow ratio; a high Froude number flow; and a wide and sufficiently long channel. (Moore-IVI)
W85-06037

ESTIMATING MEAN VELOCITY IN MOUNTAIN RIVERS,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
C. R. Thorne, and L. W. Zevenbergen.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 612-624, April, 1985. 4 Fig, 3 Tab, 16 Ref, 1 Append.

Descriptors: *Mountain rivers, *Velocity, *Estimation, Boulders, Bed roughness, Slope, Water depth, Mathematical equations, Flow discharge, Flow resistance.

It is often necessary to estimate the mean velocity is ungaged mountain rivers, but the flow resistance equations available for this purpose require further testing and development. Such rivers are characterized by coarse bed materials, steep slopes, and low depths. For these conditions, boulders protrude well into or completely through the flow, and bed roughness is said to be large-scale. Recently, three equations specifically intended for large-scale roughness have been developed to address this problem. Data from a mountain river were used to test the equations. All were prone to errors of the order of 30%. The errors were systematic, all the equations tending to overestimate mean velocity compared to observed values. An investigation of the possible sources of error suggested that sampling error in the knowledge of bed material size was a major source of uncertainty in the predicted velocities, but that this and discharge errors could not wholly account for the observed discrepancies. Boulder shape is not represented in the equations, but this was discounted as an important parameter on the basis of a flume study. It was concluded that further research is required to produce a reliable, process based, flow resistance equation for mountain rivers. (Author's abstract)
W85-06038

FLOW RESISTANCE ESTIMATION IN MOUNTAIN RIVERS,
Institute of Hydrology, Wallingford (England).
J. C. Bathurst.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 625-643, April, 1985. 8 Fig, 2 Tab, 35 Ref.

Descriptors: *Flow resistance, *Mountain rivers, *Estimation, Slope, Mathematical equations, Channel morphology, Particle size, Friction, Sediment transport, Bed load, Submergence.

Examination of the flow resistance of high-gradient gravel and boulder-bed rivers, using data collected in British mountain rivers with slopes of 0.4-4%, shows that there are differences in resistance variation between mountain and lowland rivers and that between-site variations do not necessarily reflect at-a-site variations. Comparison of data with the familiar resistance equation relating the Darcy-Weisbach friction factor to the logarithm of relative submergence shows that the equation tends to overestimate the resistance in uniform flow. The equation also tends to underestimate the rate of change of resistance at a site (as discharge varies) at high gradients. The influences of nonuniform channel profile, sediment size distribution, channel slope and sediment transport are reviewed, but the data do not allow any quantification of these effects. Instead an empirical approach based on the available data is presented, allowing the friction factor to be calculated from the relative submergence with an error of up to +/- 25% to +/- 35%. A summary of the field data is included. (Author's abstract)
W85-06039

WATER AND SEDIMENT ROUTING THROUGH CURVED CHANNELS,
San Diego State Univ., CA.
H. H. Chang.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 644-658. April, 1985. 6 Fig, 28 Ref.

Descriptors: *Sediment routing, *Water routing, *Curved channels, Alluvial channels, Simulation, Mathematical models, Sediment transport, Simulation, Streambeds, Channel morphology, Banks, Transverse circulation, Fluid dynamics.

A mathematical model for water and sediment routing through curved alluvial channels is developed and applied in a case study. This model, which is for alluvial streams with nonerodible banks, may be employed to simulate stream bed changes during a given flow, thereby providing the necessary information for the design of dikes, levees, or other bank protection. This model incorporates the major effects of transverse circulation, inherent in curved channels, on the flow and sediment processes. In the simulation of the evolution in stream bed profile, the effect of transverse flow is tied in with the aggradation and degradation development. River flow through curved channels is characterized by the changing curvature, to which variations of flow pattern and bed topography are closely related. Simulation of these changing features is based upon the fluid dynamics governing the growth and decay of transverse circulation along the channel. (Author's abstract)
W85-06040

MATERIAL AND SITE CONTROLS OF STREAM BANK VEGETATION,
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
E. H. Grissinger, and A. J. Bowie.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1829-1835, November-December, 1984. 11 Fig, 1 Tab, 7 Ref.

Descriptors: *Stream banks, *Vegetation, *Mississippi, Banks, Channeling, Vegetation effects, Streambeds.

This article describes three specific conditions which limit the establishment of permanent vegetative cover for many stream banks in northern Mississippi. Critical conditions are imposed either directly or indirectly by the properties and failure mechanisms of the bank materials. These materials are primarily outcrops of valley-fill units that were deposited during the Holocene Epoch. Material properties and failure mechanisms are relatively consistent within units but differ between units. Two of these specific conditions involve bank height and angle. For a given material, these site conditions indirectly limit vegetation by controlling mass failure frequencies. Bank instability occurred when bank heights and/or angles were greater than critical, resulting in a loss of vegetative cover. The third condition was imposed by distinctive properties of the early-Holocene massive silt unit. This material is dense and has a well-developed polygonal structure that causes near-vertical bank angles. Outcrops of this material in the channel bank are typically barren of vegetation, but many such outcrops have been relatively stable except where channel entrenchment has exposed excessively weak toe materials. These results establish that bed and bank-toe stability is a prerequisite to the development of permanent vegetation on channel banks for this study area in northern Mississippi. Additionally, these results illustrate the usefulness of classifying channel bed and bank materials as units of the valley-fill system. (Author's abstract)
W85-06095

OVERVIEW OF FACTORS AFFECTING RIVER STABILITY,
For primary bibliographic entry see Field 2J.
W85-06108

EFFECT OF BRIDGE PIERS ON STREAMFLOW AND CHANNEL GEOMETRY,
J. C. Blodgett.
Transportation Research Record, Vol. 950, No. 2, p 172-183, 1984. 10 Fig, 7 Tab, 4 Ref.

Descriptors: *Streamflow, *Channel morphology, *Piers, Scour, Bridges, Streambeds, River beds, Abutments.

Piers in the waterway affect the velocity distribution across the channel and may act as barriers to floating debris. In addition, they also affect channel geometry by causing general and local scour in the vicinity of the bridge. The level of hydraulic efficiency of an unobstructed channel may be reduced by several percent if piers are placed in the waterway. Reductions of up to 11 percent were observed at sites used in the study. Field studies of several channels indicate that depths of general scour may be greater than local scour. Maximum depths of general scour usually occur midway between piers. General scour may extend several hundred feet upstream and downstream from the bridge. Large piers in alluvial channels may initiate long-term general scour that may continue for decades. General scour at a bridge had been observed to cause enlargement of the channel by as much as 23 percent to compensate for reduced flow area and flow inefficiency associated with bridge piers. Pier design should consider the probability that the channel alignment and geometry will change with time. To reduce the potential for pier damage by streamflow; pier shape, size, spacing, location in the channel, and footing elevation relative to the lowest point in the channel bed should be considered. Pier size should individually or collectively occupy not more than about 5 percent of the original waterway at bankfull discharge. (Author's abstract)
W85-06110

DESIGN GUIDELINES FOR SPUR-TYPE FLOW-CONTROL STRUCTURES,
For primary bibliographic entry see Field 8A.
W85-06112

COMPARISON OF PREDICTION EQUATIONS FOR BRIDGE PIER AND ABUTMENT SCOUR,
For primary bibliographic entry see Field 2J.
W85-06113

COMPUTER-BASED PREDICTION OF ALLUVIAL RIVERBED CHANGES,
For primary bibliographic entry see Field 2J.
W85-06117

MODELING GENERAL SCOUR AT BRIDGE CROSSINGS,
For primary bibliographic entry see Field 2J.
W85-06118

MATHEMATICAL MODEL FOR ESTIMATING SCOUR THROUGH BRIDGE CROSSINGS,
For primary bibliographic entry see Field 2J.
W85-06119

ROLE OF CALIBRATION IN APPLICATION OF HEC-6,
For primary bibliographic entry see Field 2J.
W85-06120

RIVER GAUGING BY ULTRASONICS IN OPEN CHANNELS: INSTRUMENTS AND EXPERIENCE ABROAD (ABFLUSSERMITTLUNG IN OFFENEN GERINNEN MITTELS ULTRASCHALLMESSUNG: IM AUSLAND EINGESETZTE GERATE UND GEWONNENE ERFAHRUNGEN),
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wasserbau und Wasserwirtschaft.
C. Rack.
Deutsche Gewasserkundliche Mitteilungen, Vol. 28, No. 5/6, p 159-163, December, 1984. 5 Fig, 9 Ref.

Descriptors: *Ultrasonics, *Flow measurement, *Open channel flow, Rivers, Velocity, Tidal effects, Backwater, Automation, Telemetry, Remote sensing, Measuring instruments.

In recent years there has been an increase in the use of acoustic flow velocity measurement (AVM) devices for river gauging in open natural channels. At gauging sites with problems such as tidal influences, backwater or very low velocities there is a trend toward the use of multipath equipment. The operational sites are equipped with up to 18 paths and have path lengths up to 1200 m. Microprocessors for measurement control, discharge calculation and error control are installed in new sites. Error messages and data are often transmitted by telemetry. AVM devices are often the only possible and/or the least expensive alternative. There are also sites where the method was only partially successful. On the whole, the operators are very satisfied with their installations, even though a few requests for future developments are still to be fulfilled. (Moore-IVI)
W85-06157

2F. Groundwater

PRESENCE OF TIN AND TUNGSTEN IN THERMAL WATERS CONNECTED WITH GRANITES OF SOME SELECTED REGIONS IN EUROPE,
Gdansk Technical Univ. (Poland).
A. Sadurski, W. Blommaert, R. Vandelannoote, and L. Van't Dack.
Annales Societatis Geologorum Poloniae, Vol. 54, No. 1/2, p 3-14, 1984. 3 Fig, 4 Tab, 16 Ref.

Descriptors: *Tin, *Tungsten, *Thermal water, *Granites, *Massifs, *Groundwater, *Pyrenees, *Rila Mountains, *Vosges, *France, *Bulgaria, Geochemistry, Molybdenum, Metals.

The dependence between occurrence of the increase in tin and tungsten ion concentrations in thermal waters and the presence of greisens and metamorphosed wall rocks in magma intrusion regions was confirmed with trace element analysis of water samples. The existence of greisens with Sn-W paragenesis appearing in acidic magmatic rocks regions is generally known. Water was sampled from geothermal regions in the Hercynian massifs of the Vosges and the Eastern Pyrenees (France) and the Rila mountains (Bulgaria). The thermal water under consideration at the lowest parts of its circulation path in the rock massif may create conditions similar to those at the hydrothermal stage of residual crystallization. Differences between the Vosgesian and the Pyrenean springs in the content of W, F, Sn and Zr, can not be simply explained by the differences in water-bearing formation and temperature. The largest difference from the geological point of view between these two areas in France is that the Vosges are situated in an active tectonic zone (near the Rhine graben). The uplift of mountains creates facilities for the deeper circulation of the groundwater and the subsequent dissolution of new parts of the mineralized veins. Elements such as F, Sn, W, Mo, and to a lesser extent, U, are enriched in the latest stage of magma cooling (hydrothermal: 100-200 C). Therefor they are situated at the roof of the batholith and are easily accessible to water. Most of the springs of the Eastern Pyrenees are situated on the border of a large batholith and no differences in their chemical compositions have been found. In the Vosges area, Plombieres-les-Bains lie further away from the central part of the batholith. Water from the latter two areas is expected to be more influenced by greisenized zones possibly present at the border of the batholith. (Collier-IVI)
W85-05857

HYDROGEOLOGICAL PROPERTIES OF THE ZALAS PORPHYRY LACCOLITH NEAR KRZESZOWICE (WLASNOSCI HYDROGEOLOGICZNE PORFIROW LAKKOLITU ZALASKIEGO KOLO KRZESZOWIC),
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Geology and Mineral Deposits.
K. Bogacz, A. F. Adamczyk, T. C. Lesniak, and J. Motyka.
Annales Societatis Geologorum Poloniae, Vol. 54, No. 1/2, p 261-278, 1984. 8 Fig, 2 Tab, 22 Ref.

Descriptors: *Hydraulic contact zones, *Pumping tests, *Poland, *Aquifers, Hydrogeology, Storage, Laccolith.

The area of Zalas near Kreszowice, about 30 km west of Kracow, is a part of the Cracow-Silesian Basin. It is made up of Quaternary, Jurassic, Permian, and Carboniferous sediments. Four aquifers connected through hydraulic contact zones of different types were distinguished in the investigated area; the corresponding hydraulic contacts were sedimentary-transgressive, tectonic, magmatic-in-

trusive, and erosional. The hydraulic structures of porphyries making up the Zalas laccolith consists entirely of thermal, tectonic and weathering fractures. Results of a pumping test were explained assuming the two-layer hydrogeological structure of the porphyry laccolith, and the inertial and storage effects of the pumping well. (Collier-IVI)
W85-05858

TRANSITION ZONE WIDTH IN GROUND WATER ON OCEAN ATOLLS,
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Civil and Systems Engineering.
R. E. Volker, M. A. Marino, and D. E. Rolston.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 659-676, April, 1985. 10 Fig, 22 Ref.

Descriptors: *Groundwater, *Atolls, *Transition zone, Seawater, Saline-freshwater interfaces, Mixing layer, Tarawa Atoll, Pumping, Mathematical studies, Aquifers.

An analytical solution for the thickness of the transition zone between fresh and seawater in aquifers on ocean islands is presented. The interface is treated as a mixing layer similar to a laminar boundary layer between fluids moving at different velocities. The method requires assumptions of homogeneous isotropic dispersion, uniform hydraulic conductivity and steady flow; all water withdrawal is assumed to occur at the water table. The slope of the sharp interface is used in the solution for the mixing layer and the sharp interface is determined using Dupuit-Forchheimer assumptions of horizontal flow. The method presented efficiently estimates the transition zone thickness, thus providing information not available from sharp interface models. The method is illustrated by application to the freshwater lens on an island of the Tarawa Atoll in the Pacific Ocean, and is used to show the effects of different pumping arrangements on the width of the mixing layer. (Author's abstract)
W85-06041

TRACING GROUNDWATER COMPONENTS BY CHEMICAL, ISOTOPIC AND PHYSICAL PARAMETERS - EXAMPLE: SCHINZNACH, SWITZERLAND,
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
E. Mazor, F. D. Vuataz, and F. C. Jaffe.
Journal of Hydrology, Vol. 76, No. 3/4, p 233-246, February, 1985. 9 Fig, 5 Tab, 9 Ref.

Descriptors: *Groundwater, *Chemical composition, *Isotopic studies, *Schinznach, *Switzerland, Hot springs, Groundwater recharge, Geohydrology, Water temperature, Altitude, Ions, Groundwater movement.

Dissolved ions, stable and radioactive isotopes, and physical data obtained from hydrologically related samples, may be processed as 'anonym' and as 'specific' tracers. Answers are obtained to questions pertaining to the number and proportions of intermixing water types, the properties of each end-member, its recharge altitude, depth of circulation, nature of the rocks passed and mode of flow. The methodology of the data processing is demonstrated on observations made over one year on a spring and a well at the spa of Schinznach, Switzerland. Two end-members are identified: (1) warm (39 C), saline (up to 85 meq/l total dissolved ions), circulating at a depth of over 640 m and passing through gypsum/anhydrite- and halite-bearing rocks; and (2) colder (21 +/- 2 C), fresher (30 meq/l total dissolved ions), circulating at a depth of approximately 240 m, passing through a sequence of gypsum/anhydrite-bearing carbonate rocks and flowing in a karstic mode. Both water types are recharged at an average altitude of 550 +/- 100 m a.s.l., a value used in identifying the recharge area. The existence of a separate hotter water body at greater depth is possible. (Author's abstract)
W85-06046

MODEL-DERIVED ESTIMATES OF GROUNDWATER MEAN AGES, RECHARGE RATES, EFFECTIVE POROSITIES AND STORAGE IN A LIMESTONE AQUIFER,
Nevada Univ. System, Las Vegas. Desert Research Inst.
M. E. Campana, and D. A. Mahin.
Journal of Hydrology, Vol. 76, No. 3/4, p 247-264, February, 1985. 4 Fig, 2 Tab, 22 Ref. NSF grant EAR7713633.

Descriptors: *Groundwater age, *Limestone aquifers, *Porosity, *Groundwater storage, *Groundwater recharge, Edwards aquifer, Texas, Water storage, Model studies, Tritium, Groundwater movement.

The Edwards aquifer of south-central Texas is a carbonate aquifer system extending from Austin southwest to Comstock, near the Mexican border. The discrete-state compartment (DSC) model of the Edwards aquifer is capable of using the spatial and temporal distributions of environmental tritium to estimate several important aquifer parameters: recharge, storage, groundwater mean ages and regional estimates of effective porosities. Although this model provided acceptable agreement with the observed tritium data, certain areas showed poor correspondence between real and simulated data. These discrepancies might be due to the use of a 3 month time step and a small number of cells. The current time step provides too much attenuation of the tritium input pulses and recharge events. More cells would provide a more realistic model of the aquifer; the sparse tritium data do not warrant the construction of a model with additional cells. DSC models can be especially useful in providing first approximations to groundwater flow systems, particularly those with sparse data or flow regimes characterized by solution channel and/or fracture flow. When calibrated with environmental isotopes or other suitable tracers, they can provide important information on the flow system and can be used to design future data collection schemes so that ultimately, more sophisticated models can be constructed. (Baker-IVI)
W85-06047

DENITRIFICATION IN A MAJOR LIMESTONE AQUIFER,
Toronto Univ. (Ontario). Dept. of Geology.
K. W. F. Howard.
Journal of Hydrology, Vol. 76, No. 3/4, p 265-280, February, 1985. 8 Fig, 2 Tab, 26 Ref.

Descriptors: *Aquifers, *Denitrification, *Limestone aquifers, Groundwater pollution, Nitrates, Drinking water, Water quality,.

The role of denitrification in the aquifer environment is extremely difficult to evaluate. Nitrate inputs are spatially and temporally variable, flow conditions are transient, and mixing frequently occurs between waters of different origins. In this study, reasonable control over the origins and histories of the groundwaters is afforded by the comprehensive availability of major-, minor-ion and environmental isotope data. Nevertheless only general conclusions concerning nitrate behavior can be drawn and specific questions remain to be answered. Denitrification can not be relied upon to reduce elevated nitrate concentrations in modern recharge waters. There is no indication of denitrification in type II waters, the older and more reducing of the two modern water types. In addition the downgradient reduction of nitrate in type I waters can be satisfactorily explained by type I-type II mixing. Only type III waters show any evidence of denitrification and these waters are over 400 yr old. The study clearly illustrates the risk of interpreting regional nitrate distributions before the origins of the groundwaters and their evolutionary behavior have been established. (Baker-IVI)
W85-06048

ARKANSAS GROUNDWATER MANAGEMENT VIA TARGET LEVELS,
Arkansas Water Resources Research Center, Fayetteville.
For primary bibliographic entry see Field 4B.
W85-06074

PREDICTING DIRECT RECHARGE OF SURFICIAL AQUIFERS,
Cornell Univ., Ithaca, NY.
B. C. Knoch, D. C. Slack, and C. L. Larson.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1739-1744, November-December, 1984. 9 Fig, 2 Tab, 15 Ref.

Descriptors: *Recharge, *Aquifers, *Computer models, Infiltration, Model studies, Evapotranspiration, Soil water extraction.

A one-dimensional, physically-based computer model was developed for predicting direct groundwater recharge. The model was verified using three years of data from an instrumented site in east central Minnesota. Although the processes of infiltration and redistribution during frozen soil periods were not modeled, the model is capable of operating during both frozen and nonfrozen soil periods. The model includes submodels for evapotranspiration, soil-water extraction, snowmelt, surface depressional storage, infiltration and redistribution. The model predicts water table level and soil moisture. Water extraction may also be modeled. The model predicted both water table elevations and soil moisture levels with reasonable accuracy over the three-year period modeled. (Author's abstract)
W85-06080

CURRENT SUBSURFACE SEAWATER INTRUSION TO BASE LEVELS BELOW SEA LEVEL,
Geological Survey of Israel, Jerusalem.
U. Kafri.
Environmental Geology and Water Science, Vol. 6, No. 4, p 223-227, 1984. 5 Fig, 30 Ref.

Descriptors: *Saline water intrusion, *Seawater, *Groundwater, *Sea level, Groundwater movement, Saline water, Saline-freshwater interfaces, Aquifers, Hydrological continuity.

The Imperial Valley, Jordan-Dead Sea Rift, and the Afar and Qattara depressions, all regions below sea level and the only regions in the world so situated, are characterized by saline and hypersaline groundwaters and lakes, phenomena that to date have been solely attributed to ancient lagoons, salt dissolution, and evaporation. Current subsurface seawater intrusion is herewith suggested as an additional mechanism responsible for the salination of these regions. This type of dynamic seawater flow is feasible where there is (a) a base level below sea level with a hydrological continuity between the two levels, and (b) a low groundwater divide between the base levels with a shallow seawater/freshwater interface situated above the base of the aquifer. (Author's abstract)
W85-06161

2G. Water In Soils

MOISTURE CONDITIONS IN HUMMOCKS AND HOLLOWS IN VIRGIN AND DRAIN SITES ON THE RAISED BOG LAAVIOSUO, SOUTHERN FINLAND,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 2H.
W85-05873

IRON MIGRATION IN SANDY PODZOLIC SOILS UNDER INCREASING HYDROMORPHISM PRODUCED BY A RESERVOIR,
Moskovskaya Sel'skokhozyaistvennaya Akademiya (USSR).
For primary bibliographic entry see Field 6G.
W85-05909

HYDRAULIC PROPERTIES OF A SANDY LOAM SOIL AS INFLUENCED BY SALINISATION AND DESALINISATION,
Central Soil Salinity Research Inst., Karnal (India).
K. L. Chawla, B. K. Khosla, and D. R. Sharma.
Irrigation Science, Vol. 4, No. 4, p 247-254, December, 1983. 5 Fig, 2 Tab, 20 Ref.

Descriptors: *Soil hydraulic properties, *Saline soils, *Soil desalinization, Hydraulic properties, Infiltration, Permeability coefficient, Soil water, Leaching, Precipitation, Soil water suction.

Infiltration, unsaturated hydraulic conductivity and soil moisture characteristic were determined before and after salinization and during desalinization in a sandy loam soil under field conditions. Soil salinization was simulated by irrigating a field plot repeatedly with water of 2.84 S/m electrical conductivity and 38 SAR. The steady state infiltration rate increased from 2.45 cm/day to 4.2 cm/day during salinization, but was reduced to 0.75 cm/day when the soil was leached with good quality water. The unsaturated hydraulic conductivity values in the wet and moist range were higher in the salinized soil as compared to those following desalinization. Field soil moisture characteristics plotted from the tensiometric data showed that the water retained at any given soil water suction remained higher in the desalinized as compared to the salinized soil. The study indicates that in freshly salinized soil, the hydraulic properties are likely to deteriorate when leached with good quality water or during periods of precipitation. The long term influence of such processes, however, needs to be studied in greater detail. (Author's abstract)
W85-05934

THEORY OF SOLUTE TRANSPORT IN SOILS FROM THE METHOD OF CHARACTERISTICS,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
D. A. Barry, J.-Y. Parlange, P. G. Saffigna, and C. W. Rose.
Irrigation Science, Vol. 4, No. 4, p 277-287, December, 1983. 1 Fig, 1 Tab, 21 Ref.

Descriptors: *Solute transport, *Method of characteristics, *Soil water, Soil properties, Dispersion, Irrigation, Rainfall, Fertilizers, Mathematical equations, Leaching.

Solute dispersion can be caused by variations in soil transport properties, or variability, both spatial and temporal, in water and solute application rates. Irrigation, rainfall, and the surface application of fertilizers are arbitrary functions of time. Because measuring distributions of solute travel time parameters is very difficult, the theory given concentrates on a second mechanism of solute dispersion, variable application rates, which is modeled with parameters more easily measured in practice. An easily-soluble form of the transport equation, which conserves mass of solute and water, has been derived. As a result of focussing on variable application rates, the model predicts solute concentrations in profiles which are averaged over a large area. Rather than individual profiles, the gross features of the field sytem are presented in the model prediction of cumulative leaching with time. (Moore-IVI)
W85-05937

INVESTIGATION OF MOISTURE-INDUCED VARIATION IN SUBGRADE MODULUS BY CROSS-CORRELATION METHOD,
For primary bibliographic entry see Field 8D.
W85-06063

SOLAR EARTH-WATER DISTILLATION FOR WET SAND,
Arkansas Univ., Fayetteville. Dept. of Agricultural Engineering.
R. C. Peralta, T. M. Skergan, and D. B. Marx.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1690-1695, November-December, 1984. 4 Fig, 5 Tab, 4 Ref.

Descriptors: *Solar distillation, *Distillation, *Soil Water, Solar stills, Design criteria, Water resources development.

Solar earth-water distillation is a means of extracting moisture from an earth medium. Three designs of the hot-box type of solar earth-water still were tested using wet or saturated sand. The designs included: low height with reflective interior siding, tall height with reflective siding and tall height with absorptive siding. The daily volume of distillate from the different designs was compared. A twenty-centimeter-tall still with reflective siding produced significantly greater yields than one twice as tall. No significant difference in the yield between tall stills with light-absorptive versus light-reflective interior siding was found. A regression equation was developed to predict water production for a low still with reflective siding and a sixteen-degree cover slope. Independent variables included soil moisture, solar radiation and maximum and minimum daily temperature. (Author's abstract)
W85-06073

SOIL PHYSICAL CHARACTERISTICS OF REDUCED TILLAGE IN A WHEAT-FALLOW SYSTEM,
Nebraska Univ.-Lincoln.
L. N. Mielke, W. W. Wilhelm, K. A. Richards, and C. R. Fenster.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1724-1728, November-December, 1984. 1 Fig, 5 Tab, 13 Ref.

Descriptors: *Soil water, *Tillage, *Wheat, *Fallowing, *Soil properties, Density, Air permeability, Infiltration, Precipitation, Runoff.

Soil physical characteristics of reduced tillage for fallow-wheat (Triticum aestivum L.) were compared for two soils in western Nebraska. The soil physical environment influences the amount of water that enters soil, the availability of water for plants, and the microenvironment important to soil biological processes. Fallow tillage (plow, subtill, no till) did not affect bulk density in Alliance silt loam (fine silty, mixed mesic, Aridic Argiustolls). For Duroc loam (fine silty, mixed mesic Pachic Haplustolls), in which native sod was compared to the above three wheat-fallow tillage methods, numerous effects on soil physical properties were found. Reduced tillage reduced bulk density in the 0- to 76-mm layer. Hydraulic conductivity (H.C.) in the surface 300 mm was greater for native sod than for plowed and subtilled soil. Air permeability (ka) was lowest and water permeability (kW) was highest in the native sod. The ratio, ka/kW, an indicator of soil structural stability, showed native sod was most stable and the plowed soil was least stable. Infiltration was least for plowed soil, and after 4 h, infiltration into subtilled, chemical, and native sod was 2.2, 2.4, and 4.7 times greater, respectively. Based on precipitation records and infiltration characteristics, water would seldom run off the surface of these soils. (Author's abstract)
W85-06078

TILLAGE EFFECTS ON CROP YIELD IN COASTAL PLAIN SOILS,
Clemson Univ., SC. Dept. of Agricultural Engineering.
C. R. Camp, G. D. Christenbury, and C. W. Doty.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1729-1733, November-December, 1984. 3 Fig, 3 Tab, 12 Ref.

Descriptors: *Tillage, *Crop yield, *Soils, *Corn, *Soybean, Rainfall, Irrigation, Soil water.

Corn (Zea mays L.) and soybean (Glycine max (L.) Merr.) were grown on an 18-ha site of Coastal Plain soils under nonirrigated and irrigated conditions for the three-year period, 1979-81. The five tillage treatments were double disking and minimum tillage, both with and without in-row subsoiling at planting; and disking with uniform chisel plowing. Rainfall during the growing season was near normal in 1979, below normal in 1981, and much below normal in 1980. There were significant yield differences due to tillage and irrigation for both corn and soybean. Corn yield increases due to deep tillage were greater in magnitude and were more consistent than those for soybean. Minimum tillage without subsoiling produced the lowest yields for both corn and soybean; however, this treatment had the poorest stand and the most severe weed competition of all treatments. Deep tillage and irrigation produced additive yield increases for corn, but not for soybean, indicating the possible need to use both management practices for corn in some soil conditions. Irrigation increased yields for both corn and soybean across all tillage treatments with mean yield increases of 3.37 t/ha (86%) and 0.73 t/ha (51%) for corn and soybean, respectively. The choice of management practices will depend upon their cost relative to their respective yield increase potential. (Author's abstract)
W85-06079

EFFECT OF SOIL SURFACE CONDITIONS ON INFILTRATION FOR SHALLOW WATER TABLE SOILS,
Georgia Coastal Plain Experiment Station, Tifton. Dept. of Agricultural Engineering.
A. Shirmohammadi, and R. W. Skaggs.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 7, p 1780-1787, November-December, 1984. 15 Fig, 5 Tab, 26 Ref.

Descriptors: *Infiltration, *Water table, *Soil water, Seasonal variation, Permeability coefficient, Cultivation, Rainfall.

Experiments were conducted to determine the effects of surface cover and changes in surface conditions on infiltration into soils with shallow water tables. The effects of initial water table depth and time of year were also considered. Experiments were conducted on columns of fine sand with bare or fallow surfaces as well as surfaces planted to fescue grass and soybeans. Highest infiltration was observed for profiles planted to grass. Most of the increase was attributed to higher hydraulic conductivity values in top 20 cm of the grass profiles. Infiltration generally decreased with time of year for all the profiles; this was mostly due to decreased hydraulic conductivity in the surface layer. Exceptions were increased infiltration due to cultivation and to drier initial conditions for some cases. Rainfall in September compacted the bare surfaces and results in lower infiltration rates in subsequent test although it had no significant effect on planted (grass and soybean) profiles. Deep initial water tables resulted in drier profiles and decreased the effect of compressed air on infiltration. This tended to increase infiltration when compared to shallow water table conditions. (Author's abstract)
W85-06087

EFFECTS OF SOIL BULK DENSITY AND WATER REGIMEN ON ROOT GROWTH AND UPTAKE OF PHOSPHORUS BY RYEGRASS,
University of New England, Armidale (Australia). Dept. of Agronomy and Soil Science.
P. S. Cornish, H. B. So, and J. R. McWilliam.
Australian Journal of Agricultural Research, Vol. 35, No. 3, p 631-44, 1984. 8 Fig, 4 Tab, 33 Ref.

Descriptors: *Soil characteristics, *Phosphorus, *Ryegrass, *Grass, *Soil water, Soil density, Roots, Root development, Soil strength.

The effects of soil density (rho) and water content on root extension, phosphorus (P) uptake and plant growth were studied with ryegrass in pot experiments with a sandy loam soil. Uptake was considered in terms of a root cylinder model with parameters of root length and uptake per unit length. Increasing rho (from 1.0 to 1.54 g/cu cm) slightly increased root diameter and reduced root hair length, but the main effect on uptake per unit length of root was related to the increased mass of soil and hence the increased mass of P within the root hair cylinder. The effect of rho on diffusion to the surface of the cylinder appeared to be small. Increasing rho also increased soil strength, causing a reduction in root length which was linearly related to P uptake. Thus the effect of rho on total P uptake was a product of the opposing effects on uptake per unit length and root length. The importance of these two effects was confirmed by calculating potential P uptake using a simple root cylinder model in which rho was a variable. Predicted and observed values were highly correlated (r squared = 0.94). Drying the soil reduced P uptake per unit length of root, but, in compacted soil, this

effect was small compared with the effect of drying on root extension. It appears that, when this soil type is not cultivated, drying will reduce P uptake mainly because mechanical resistance reduced root extension, and root extension ceased well within the available water range in intact soil cores. (Author's abstract)
W85-06098

SOIL SALINITY STATUS AND ITS RELATION TO SOME OF THE SOIL AND LAND PROPERTIES OF THREE IRRIGATION DISTRICTS IN SOUTHERN ALBERTA,
Department of Agriculture, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 4A.
W85-06151

COMPARISON OF MODELLED SOIL WATER RESERVES ON CANADIAN PRAIRIE SOILS WITH WATER-HOLDING CAPACITIES OF 280 AND 250 MM,
Department of Agriculture, Ottawa (Ontario). Land Resource Research Inst.
R. de Jong, and W. K. Sly.
Canadian Journal of Soil Science, Vol. 65, No. 1, p 219-223, February, 1985. 2 Tab, 6 Ref.

Descriptors: *Soil water, *Model studies, *Prairie soils, Water-holding capacity, Aridity index, Wheat, Water deficit, Rainfall distribution, Temporal distribution, Drought.

Based on soil water modelling results of 19 stations, averaged long-term soil water reserves on the Canadian Prairies were compared for two soils having available water-holding capacities of 280 and 250 mm. The soil water reserves of the 250-mm capacity soil were 6.5%, 8.7% and 6.2% less than those of the 280-mm capacity soil on 1 May after a fallow year, 30 June heading time and 1 May after a crop year, respectively. The aridity indices for wheat at the soft dough stage for the 250-mm capacity soil ranged from 4% less in the drier part of the Prairies to 7-9% more in the wetter regions as compared to the 280-mm capacity soil. Water deficits for a perennial crop grown on a 280-mm capacity soil could not be used to infer the deficits on a 250-mm capacity soil because of the model's sensitivity to rainfall distribution with time. (Author's abstract)
W85-06152

PREDICTING VOLUMETRIC WATER RETENTIONS FOR SUBSOIL MATERIALS FROM COLCHESTER COUNTY, NOVA SCOTIA,
Department of Agriculture, Truro (Nova Scotia). Atlantic Soil Survey Unit.
G. J. Beke, and M. J. MacCormick.
Canadian Journal of Soil Science, Vol. 65, No. 1, p 233-236, February, 1985. 2 Tab, 7 Ref.

Descriptors: *Soil water, *Volumetric water retention, *Colchester County, *Nova Scotia, Soil properties, Soil water suction, Bulk density, Organic matter, Sand, Silt, Clay, Mathematical equations.

Water retention characteristics and pertinent soil properties were determined for soil survey samples from Colchester County, Nova Scotia, in order to develop the relationships between volumetric soil water content, at suctions of 33 and 1500 kPa, and organic matter, bulk density, and sand, silt, and clay content for subsoil materials. The significant variables in the regression equation for soil water content at a suction of 33 kPa were the sand content and the product of silt content and bulk density of the soil. The variables for water retention at 1500 kPa suction were the clay content and the product of organic matter content and bulk density. The multiple correlation coefficients were 0.87 and 0.92 for suctions of 33 and 1500 kPa, respectively. The soil water retentions at suctions of 33 kPa and 1500 kPa were estimated adequately by the developed equations from sand, silt, clay, organic matter, and bulk density. (Moore-IVI)
W85-06154

2H. Lakes

TROPHIC RELATIONSHIPS BETWEEN BACTERIA AND PROTOZOA IN THE HYPOLIMNION OF A MEROMICTIC MESOTROPHIC LAKE,
Innsbruck Univ. (Austria). Dept. of Limnology.
R. Psenner, and K. Schlott-Idl.
Hydrobiologia, Vol. 121, No. 2, p 111-120, February, 1985. 5 Fig, 2 Tab, 41 Ref.

Descriptors: *Bacteria, *Protozoa, *Mesotrophic lakes, *Trophic level, *Hypolimnion, Nutrients, Nitrates, Nitrites, Organic carbon, Biomass, Lakes, Phosphorus.

The development of ciliated protozoan biomass in the hypolimnion of Piburger See, a small subalpine lake, was demonstrated to depend mainly on two factors. Firstly, the availability of oxygen or nitrate as electron acceptors determines the depth profiles of ciliates. Large quantities of ciliates and even maximum numbers were found at depths where no oxygen could be detected. If nitrate also disappeared during the summer stagnation period, the biomass of protozoa was strongly reduced. Nitrite peaks generally corresponded with ciliate peaks. An extension of Finlay's findings (dissimilatory nitrate reductase within the inner mitochondrial membrane) to other ciliate groups is hypothesized. Secondly, the biomass development of hypolimnetic ciliates was strongly correlated with the bacterial biomass registered approximately 2 weeks before (r squared = 0.891, n = 14). The biomass of bacteria, on the other hand, was dependent upon the sedimentation rate of organic carbon (r squared = 0.850, n = 15), if a time lag of approximately 2 weeks was taken into account. Therefore a total time lag of approximatly 4 weeks was assumed to take place between sedimentation of organic substance and the corresponding increase in ciliate biomass (r squared = 0.853, n = 14). Bacteria were shown to be an important intermediate link in the food chain of the hypolimnion. They appear to represent the principal energy source for pelagic ciliates. Sedimentation of organic carbon, nitrogen and phosphorus is the driving force for the establishment of the hypolimnetic microbial community. (Author's abstract)
W85-05864

SULFUR DISTRIBUTION IN LAKE SEDIMENT PROFILES AS AN INDEX OF HISTORICAL DEPOSITIONAL PATTERNS,
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
For primary bibliographic entry see Field 5B.
W85-05865

CHIRONOMIDAE IN A PENNINE STREAM SYSTEM RECEIVING MINE DRAINAGE AND ORGANIC ENRICHMENT,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 5C.
W85-05868

CHLOROPHYLL-NUTRIENT RELATIONSHIPS IN NORTH ISLAND LAKES (NEW ZEALAND),
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
R. D. Pridmore, W. N. Vant, and J. C. Rutherford.
Hydrobiologia, Vol. 121, No. 2, p 181-189, February, 1985. 6 Fig, 5 Tab, 34 Ref.

Descriptors: *Chlorophyll, *Nutrients, *New Zealand, *North Island, *Lakes, Model studies, Nitrogen, Phosphorus, Water depth, Seasonal variation.

A model for the prediction of chlorophyll alpha in the near surface waters (1 m) of North Island lakes was developed using data from the literature and a study of 12 North Island lakes. Annual geometric mean concentrations of chlorophyll alpha, total nitrogen and total phosphorus were used since no distinct growing season was discernable. Annual mean ratios of total nitrogen to total phosphorus in the near surface waters ranged between 10 and 59 (by weight). Strong correlations were obtained between log-transformed values of chlorophyll alpha and total nitrogen (r squared = 0.53, n = 16), chlorophyll alpha and total phosphorus (r squared = 0.71, n = 21), and between total nitrogen and total phosphorus (r squared = 0.69, n = 16). After correcting for the high interdependency between total nitrogen and total phosphorus, only total phosphorus was found to be important in predicting chlorophyll concentrations. Much of the variance in the chlorophyll-phosphorus relation was attributable to differences in mean lake depth. Lakes with mean depths less than 11 m had significantly more chlorophyll alpha per unit of total phosphorus (mean = 0.54 micro g/micro g, SE = 0.05, n = 6) than lakes of greater mean depth (mean = 0.17 micro g/micro g, SE = 0.02, n = 14). When the effect of mean depth was taken into account, 89% of the variance in chlorophyll alpha was explained compared with 71% for the similar linear regression on total phosphorus alone. (Author's abstract)
W85-05869

MOISTURE CONDITIONS IN HUMMOCKS AND HOLLOWS IN VIRGIN AND DRAIN SITES ON THE RAISED BOG LAAVIOSUO, SOUTHERN FINLAND,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
T. Lindhomlm, and I. Markkula.
Annales Botanici Fennici, Vol. 21, No. 3, p 241-255, 1984. 8 Fig, 4 Tab, 60 Ref.

Descriptors: *Bogs, *Bog Laaviosuo, *Finland, *Soil water, *Hummocks, *Hollows, Water table, Rainfall, Wetlands, Mires, Peat bogs.

The dynamics of the water table and soil water tension in the surface peat was studied in a raised bog. Comparisons were made between hummocks and hollows in two consecutive summers, and also between virgin and drained sites. In most cases a linear regression gave a good fit for the relationship between soil water tension in the surface peat and the distance to the water table. An exception was the relationship in the drained hummock, where the water table was lower; when rain occurred as infrequent showers, the relationship between the soil water tension and the water table level was logarithmic. Under such conditions, the moisture tension in the drained hummock was mainly regulated by the rain and not by the height of the water table. Hollows which are wet in the virgin state remain rather wet even after drainage. The relationship between the height of the water table and soil water tension was similar at different depths in the surface peat; only the magnitude of the tension changed with the depth in the peat. There was also a clear relationship between the levels of the water tables in virgin and drained sites. Heavy rains, however, caused deviations from this relationship, due to the difference in the rate of runoff from the two sites. The regression was slightly curvilinear, because the levels in the two sites converged when the water table was deep. The biological consequences of the soil water conditions in virgin and drained sites were reviewed. (Author's abstract)
W85-05873

EXCRETION OF PHOTOSYNTHETICALLY FIXED ORGANIC CARBON BY METALIMNETIC PHYTOPLANKTON,
Purdue Univ., Lafayette, IN. Dept. of Biological Sciences.
C. R. Lovell, and A. Konopka.
Microbial Ecology, Vol. 11, p 1-9, 1985. 3 Fig, 5 Tab, 20 Ref. NSF grant DEB-8201857 and Office of Water Resources and Technology grant B-127:IND.

Descriptors: *Photosynthesis, *Phytoplankton, *Little Crooked Lake, *Indiana, *Organic carbon, Hydrogen ion concentration, Dissolved oxygen, Bacteria, Algae, Light intensity.

The effects of light intensity, oxygen concentration, and pH on the rates of photosynthesis and net excretion by metalimnetic phytoplankton popula-

tions of Little Crooked Lake, Indiana, were studied. Photosynthetic rates increased from 1.42 to 3.14 mg C/mg chlorophyll a/hour within a range of light intensities from 65 to 150 micro E/sq m/sec, whereas net excretion remained constant at 0.05 mg C/mg chlorophyll a/hour. Bacteria assimilated approximately 50% of the carbon released by the phytoplankton under these conditions. Excreted carbon (organic compounds either assimilated by bacteria or dissolved in the lake water) was produced by phytoplankton at rates of 0.02-0.15 mg C/mg chlorophyll a/hour. These rates were 6%-13% of the photosynthetic rates of the phytoplankton. Both total excretion of carbon and bacterial assimilation of excreted carbon increased at high light intensities whereas net excretion remained fairly constant. Elevated oxygen concentrations in samples incubated at 150 micro E/sq m/sec decreased rates of both photosynthesis and net excretion. The photosynthetic rate increased from 3.0 to 5.0 mg C/mg chlorophyll a/hour as the pH was raised from 7.5 to 8.8. Net excretion within this range decreased slightly. Calculation of total primary production using a numerical model showed that whereas 225.8 g C/sq m was photosynthetically fixed between 12 May and 24 August 1982, a maximum of about 9.3 g C/sq m was released extracellularly. (Author's abstract)
W85-05876

AQUATIC INSECT ABUNDANCE IN A REGULATED STREAM UNDER FLUCTUATING AND STABLE DIEL FLOW PATTERNS,
Washington Univ., Seattle. Fisheries Research Inst.
J. C. Gislason.
North American Journal of Fisheries Management, Vol 5, No. 1, p 39-46, 1985. 4 Fig, 1 Tab, 24 Ref.

Descriptors: *Skagit River, *Washington, *Water level fluctuations, *Regulated flow, *Ecological effects *Aquatic insects, Fish, Population density.

Aquatic insect abundance at water depths of 15-45 cm was examined in a fifth-order reach of the Skagit River, Washington from May to November in 1976 and 1977. The study site was subject to diel flow fluctuation in 1976 from hydroelectric powerpeaking, and to a relatively stable flow pattern in 1977 while peaking was curtailed. Under fluctuating flow conditions, insect density increased from shallow to deep water and was negatively correlated ($r = -0.76$, $P < 0.001$) with hours of dewatering during the 2 weeks prior to sampling. Current fluctuation appeared to limit insect density at the 45-cm deep sampling locations that were not extensively dewatered during the daily peaking cycle. The highest density observed in 1976 was 1,788 insects/sq m at 25 cm in July. Under stable flow conditions, the abundance of benthic insects was greatly enhanced and the densities at corresponding depths and months were 1.8-59 times higher in 1977 than in 1976. Insect densities increased steadily from May 1977 through September 1977 when they reached a maximum level of 16,763 insects/sq m at 15 cm. Reduction in the amplitude and duration of powerpeaking flow fluctuation can be a highly effective management strategy for enhancing aquatic insect standing crop, with a potential for increasing the survival and growth of fish dependent on insects for food. (Author's abstract)
W85-05880

STUDIES OF THE INTERNAL WAVE IN SMALL LAKES (II) - EFFECT OF THE LAKE BASIN SHAPE ON THE INTERNAL WAVE - (IN JAPANESE),
Hokkaido Univ., Sapporo (Japan). Dept. of Geophysics.
S. Kodomari.
Japanese Journal of Limnology, Vol. 45, No. 4, p 269-278, October, 1984. 10 Fig, 2 Tab, 13 Ref.

Descriptors: *Internal waves, *Lake basins, *Water circulation, *Lakes, Mathematical models, Islands, Model studies.

Using the two-layer model, numerical calculations were made for 24 small lake models. Two types of internal wave are noted dominantly. The one rotates counterclockwise round the basin by the effect of the earth's rotation, and the other clockwise. The former is characterized by the uninodal longitudinal mode in the zero-rotation case and the latter is the uninodal transverse one. Due to the lake basin shape, the period of the counterclockwise internal wave is prolonged. The island makes the period of the clockwise internal wave longer. When the length of the minor axis is shortened by the lake basin shape, the clockwise internal wave is not dominant in the complex figure model or its period becomes shorter than that of the rectangular lake model. There are cases where the magnitude of displacement of two internal waves is reversed at some position in the lake. The effect of the lake basin shape is larger on the clockwise internal wave than on the counterclockwise one. (Author's abstract)
W85-05998

CIRCULAR CURRENTS IN THE NORTH BASIN OF LAKE BIWA (II) - COMPARISONS BETWEEN OBSERVED CURRENT AND GEOSTROPHIC CURRENT - (IN JAPANESE),
Shiga Univ., Otsu (Japan). Dept. of Earth Science.
S. Endoh.
Japanese Journal of Limnology, Vol. 45, No. 4, p 289-295, October, 1984. 6 Fig, 3 Tab, 10 Ref.

Descriptors: *Water currents, *Geostrophic currents, *Lake Biwa, *Japan, Water circulation, Lake basins, Water temperature, Water depth, Internal waves, Centrifugal force.

In order to determine the validity of applying a geostrophic relationship to the circular currents in Lake Biwa, a series of quasi-simultaneous observations of currents and water temperature were carried out. The current measurements were made using the drifters with cross-board placed at several depths. The vertical profiles of water temperature were measured by the bathythermograph at four points about 500 m away from the current station. The comparisons between the directly measured current and estimated geostrophic current show that the geostrophic approximation is not so valid for the current observed at a specified time and space. On the other hand, the current averaged over a time long enough to cancel the effect of the slowest internal wave, can serve as the baroclinic geostrophic current including the centrifugal force. (Author's abstract)
W85-05999

CHLOROPHYLL DIFFERENCES IN MONO LAKE (CALIFORNIA) OBSERVABLE ON LANDSAT IMAGERY,
California Univ., Santa Barbara. Dept. of Geography.
E. Almanza, and J. M. Melack.
Hydrobiologia, Vol. 122, No. 1, p 13-17, March, 1985. 2 Fig, 3 Tab, 18 Ref.

Descriptors: *Chlorophyll, *Satellite technology, *Remote sensing, *Mono Lake, *California, Saline lakes, Reflectance, Transparency, Landsat.

Mono Lake (California) is a large, deep, saline lake in the North American Great Basin. Mono Lake was sampled during 1979 at ten sites distributed lake-wide at the time of two Landsat overpasses and at one site (middle of western bay) in conjunction with five radiometric measurements made at the lake. Chlorophyll concentrations in the euphotic zone increased from 4 to 45 micro-g/l between July and October 1979. These seasonal changes in chlorophyll are detectable on imagery obtained with the multispectral scanner on Landsat. Computer-compatible tapes of Landsat images were normalized for solar zenith and corrected for atmospheric scatter and absorption to obtain Landsat emittances. Variation in per cent reflectance are not consistently correlated with the changes in chlorophyll concentration. It is possible that the coccoid green alga that dominates the phytoplankton of Mono Lake provides an especially weak signal to the hand-held Landsat radiometer. The per cent reflectances in bands 5, 6, and 7 are even lower than those in band 4 and interpretation of the small differences among the days is equivocal. Correlation coefficients were determined for Landsat values in bands 4, 5, and 6, individually correlated against chlorophyll and Secchi disk transparency for the Landsat imagery from July and October for the separate images. Spatial heterogeneity was not detectable. (Moore-IVI)
W85-06004

INTERNAL PHOSPHORUS LOADING TO SHALLOW EDINBORO LAKE IN NORTHWESTERN PENNSYLVANIA,
Pittsburgh Univ., PA. Dept. of Biological Sciences.
K. J. Garber, and R. T. Hartman.
Hydrobiologia, Vol. 122, No. 1, p 45-52, March, 1985. 5 Fig, 4 Tab, 30 Ref.

Descriptors: *Phosphorus, *Internal loading, *Edinboro Lake, *Pennsylvania, Nutrients, Eutrophic lakes, Stratification, Lake sediments, Chlorophyll, Anaerobic conditions.

Edinboro Lake (Pennsylvania) is small, shallow and highly productive. The mean, volume-weighted summer epilimnetic total phosphorus concentration exceeds 60 micro-g/l and the mean summer stratification Secchi depth is on the order of 1.5 m. A mass balance phosphorus model was used to develop a phosphorus budget for Edinboro Lake during the stratification period (mid-June to mid-August) in 1981 and 1982. Strong clinograde temperature and dissolved oxygen profiles developed during summer stratification in Edinboro Lake. Phosphorus loading from internal sources contributed 141 kg (79%), and 55 kg (68%), of the mass phosphorus increase in the lake in 1981 and 1982, respectively. Calculated anaerobic sediment release rates of total phosphorus were 9.9 and 3.7 mg/sq m/day for these two years. Chlorophyll a concentration ranged from a prestratification minimum of 4 mg/cu m to a maximum concentration of 33 mg/cu m in 1981. The observed summer maximum chlorophyll a concentration was 1.5-3 times greater than that predicted by existing models. Since the absolute size of the internal phosphorus load in lakes is so variable and since morphometry influences the unique response of each lake following nutrient abatement, it is difficult to predict how long internal loading will influence trophic state after external nutrient diversion. (Moore-IVI)
W85-06006

PRIMARY PRODUCTION IN TEN RESERVOIRS IN SOUTHERN BRAZIL,
Sao Paulo Univ. (Brazil). Inst. Oceanografico.
S. M. F. Gianesella-Galvao.
Hydrobiologia, Vol. 122, No. 1, p 81-88, March, 1985. 7 Fig, 1 Tab, 27 Ref.

Descriptors: *Primary productivity, *Reservoirs, *Sao Paulo State, *Brazil, Seasonal variation, Chlorophyll a, Phytoplankton, Solar radiation, Water depth, Nutrients, Turbidity.

Through 1979, phytoplankton primary production of ten reservoirs in Sao Paulo State (Brazil) was measured using the C-14 method. Each reservoir was sampled four times during the year: twice during the warmer (summer) period and twice during the cooler (winter) period. Production rates, depth, profiles and integral productivity were analyzed with respect to chlorophyll-a data and various abiotic environmental factors. The vertical distribution of primary production showed normal surface maxima even under high radiation, attributable to a predominance of phytoplankton communities with 'sun type' behavior (high production rates under high solar radiation. Productivity was low (except in the euthrophic Americana Reservoir), and peaked in summer. Maximum production rates in the depth profiles ranged from 0.8 to 160.3 mg C/sq m/h, and integral production from 0.8 to 92.1 mg C/sq m/h. Nanoplankton was responsible for most of the primary production. The limiting factors were nutrients (mainly phosphate) and turbidity, during winter in the monomictic reservoirs and much of the year in the polymictic reservoirs. (Moore-IVI)
W85-06008

ECOLOGY OF THE LIMNOFAUNA IN THE RIVER KOSI OF THE KUMAUN HIMALAYA (UTTAR PRADESH),
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
S. D. Bhatt, Y. Bisht, and U. Negi.
Proceedings of the Indian National Science Academy, Vol. B50, No. 4, p 395-405, August, 1984. 5 Fig, 2 Tab, 27 Ref.

Descriptors: *Aquatic animals, *Rivers, *Kosi, *India, Invertebrates, Fish, Turbidity, Velocity, Dissolved oxygen, Seasonal variation, Benthic fauna, Aquatic insects, Biomass.

The river Kosi, on of the major rivers draining a large area along the central and south-central parts of the Kumaun Himalaya, is joined by several spring-fed tributaries. Hydrobiological studies in a 47 km stretch of the river were conducted during January 1982 - December 1983. Physico-chemical factors such as turbidity, velocity and dissolved oxygen depicted subtle seasonal variations and were found to alter the biological balance of the river water. The river water represented a mixed assemblage of a wide variety of micro and macro-invertebrates. A sharp distinction and a definite variability in the numerical dominance of a certain species was not characteristically observed in different sections of the river. The main bulk of the benthic fauna was comprised of insect nymphs and larvae. The biota showed highest biomass in the winter-summer interphase and a depression in the rainy season. Random surveys of the Kosi identified an enormous potential for the development of the fish fauna through management. The headwater zone was dominated by rheophilic species (loaches and catfish), the rapid but clear-water zone by snow-trout, mahaseer and a few loaches, and the rapid turbid-water zone by snow-trout, mahaseer and minor carps. (Moore-IVI)
W85-06011

PHYSIOGRAPHY AND LIMNOLOGY OF THREE LAKES IN THE ENVIRONS OF THE UNION TERRITORY OF DELHI, INDIA,
Delhi Univ. (India). Ecology and Experimental Taxonomy Lab.
K. M. M. Dakshini, and S. K. Gupta.
Proceedings of the Indian National Science Academy, Vol. B50, No. 4, 417-430, August, 1984. 2 Fig, 6 Tab, 42 Ref.

Descriptors: *Limnology, *Physiography, *Badkhal Lake, *Peacock Lake, *Damdama Lake, *India, Vegetation, Reservoirs, Eutrophication, Physico-chemical properties, Geology.

Badkhal and Peacock lakes are situated in the southern part of the Union territory of Delhi, India. Damdama is situated southeast of Delhi. The climate of the area is of semi-arid type with marked diurnal differences in temperature, high saturation deficit and moderately low rainfall. The vegetation cover in and around the catchment area of these lakes is an open scrub. Badkhal Lake was created in the early 20th century by making an earthen wall across the Parsaun Nadi (river). Damdama Lake is a man-made perennial impoundment which is bounded on three sides by high hillocks and on the west by a bund (earthen wall) constructed during 1947-1949. Peacock Lake is situated in a valley which has been dammed since 1908 by a bund. Investigations on geography, geology, physico-chemical and biological characteristics of the three small freshwater lakes suggested that age of a lake and the ecological processes prevalent in the catchment area are of greater importance in controlling its maturation and stability than its geography. Eutrophication in these lakes is partly natural and partly cultural. (Moore-IVI)
W85-06012

BIOLOGY AND MANAGEMENT OF AN INLAND SALINE LAKE,
Crewe and Alsager Coll. of Higher Education, Alsager (England).
A. A. Savage.
Biological Conservation, Vol. 31, No. 2, p 107-123, 1985. 5 Fig, 2 Tab, 25 Ref.

Descriptors: *Saline lakes, *Watch Lane Flash, *Cheshire, *England, *Ecological effects, *Species composition, Saline water, Lakes, Lake management, Precipitation, Inverterates, Aquatic plants.

Annual quantitative changes in the species composition of the higher plant flora and macroinvertebrate fauna of an inland saline lake during the period 1969-79 were compared with environmental data relating to temperature, conductivity of surface waters and major management decisions. Changes in species composition of the flora and fauna of Watch Lane Flash, Sandbach, Cheshire, England, showed considerable variation in relation to environmental factors of both natural and human origin. An attempt was made to determine causal relationships with the aid of other relevant data. Flora and fauna formed a rare community reflecting the saline conditions similar to communities in coastal regions. The primary relationship of the flora was with brackish coastal waters wheras the primary relationship of the fauna was with local fresh water. Rapid fluctuations in the community of the flash show that it was extremely sensitive to environmental factors. Net precipitation was the main factor governing conductivity. The two major changes were initiated by human activity. The modifications to drainage from the brine springs in 1971 were designed to prevent flooding of the road and effects on the flash were not considered. The transfer of water from the canal was an example of deliberate management intended to conserve the saltmarsh and fish population. Both had unforseen consequences for the community. Landscaping and the lowering of the water level were successful in that no unexpected effects were noticed. The main objective of management should be to counteract the fundamental chemical and biological instability of the habitat; it may then fluctuate within a more natural range. Successful management for conservation is dependent upon the maintenance of a stable water level. (Collier-IVI)
W85-06101

LONG-TERM PATTERNS OF PROTOZOAN COLONIZATION IN DOUGLAS LAKE, MICHIGAN,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. R. Pratt, and J. Cairns, Jr.
Journal of Protozoology, Vol. 32, No. 1, p 95-99, February, 1985. 3 Fig, 3 Tab, 30 Ref.

Descriptors: *Protozoa, *Douglas Lake, *Michigan, *Aquatic animals, Microorganisms, Species composition, Substrates.

Long-term patterns of noninteractive and interactive protozoan colonization of polyurethane foam (PF) artificial substrates in Douglas Lake, Michigan, were examined for a 14-yr period. Species-time data were fitted to the MacArthur-Wilson equilibrium model, S = (S sub eq)(1 - (e to the -Gt power)), and examined through time from 1969-1982. Comparisons were made to historical water chemistry measurements. No long-term changes in water chemistry were evident. Similarly, equilibrium species number (S sub eq) and colonization rate (G) oscillated about a mean through time. Protozoan colonization of PF substrates appeared stable for extended periods and showed modest variation from year to year. Examination of 7-yr-old substrates in 1982 revealed little difference from young (< 50 days) substrates. Previous reports of senescence of artificial substrate communities may have been due to habitat loss within the substrates. No evidence existed for chemical or biological degradation of the lake. (Collier-IVI)
W85-06134

VERTICAL DISTRIBUTION OF POTENTIALLY PATHOGENIC FREE-LIVING AMOEBAE IN FRESHWATER LAKES,
Clemson Univ., SC. Dept. of Biological Sciences.
D. E. Kyle, and G. P. Noblet.
Journal of Protozoology, Vol. 32, No. 1, p 95-105, February, 1985. 7 Fig, 3 Tab, 53 Ref.

Descriptors: *Amoeba, *Lakes, *Aquatic animals, *Vertical distribution, *Pathogens, Monomictic lakes, Thermal stratification, Phytoplankton, Stratification, Distribution.

The vertical distribution of thermotolerant (37 C and 45 C) free-living amoebae (FLA) in warm monomictic lakes was determined in relation to the onset of thermal stratification and associated physical and chemical changes. The position of abiotic or biotic particulate layers in the water column was located by using a submersible horizontal beam transmissometer that measures attenuance, or the adsorption and scattering of light by particulates in the water column. During mixis, the vertical distribution of amoebae was sporadic with significant numbers of FLA only occurring in clay layers caused by runoff after heavy rains. With the onset of thermal stratification in the lakes, phytoplankton layers began to form. Few amoebae were isolated from layers containing flagellated phytoplankton; however, significant ($P < 0.005$) numbers of FLA were isolated from two particulate layers dominated by the filamentous blue-green algae Aphanizomenon and Lyngbya, respectively. By late June, a persistent detrital or decomposition layer formed in the lower metalimnion, as well as a hypolimnetic iron layer where the Fe(2+) state was predominant. In this midsummer period, 13 Naegleria fowleri were isolated, with three from the detrital layer and seven from the iron layer. The presence of attenuation zones was found to be the best indicator of the vertical distribution of FLA in the water column, and such layers represent an important, previously undescribed habitat for potentially pathogenic FLA. (Author's abstract)
W85-06135

COPPER-BINDING CHARACTERISTICS OF EXOPOLYMERS FROM A FRESHWATER-SEDIMENT BACTERIUM,
California State Univ., Long Beach. Dept. of Microbiology.
M. W. Mittelman, and G. G. Geesey.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 846-851, April, 1985. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Copper, *Sediments, *Exopolymers, *Bacterial metabolism, Humic acids, Xanthan, Carbohydrates, Metals, Fate of pollutants.

Copper-binding activity by exopolymers from adherent cells of a freshwater-sediment bacterium was demonstrated by a combination of equilibrium dialysis and flameless atomic absorption spectrometry. Crude, cell-free exopolymer preparations containing protein and polysaccharide components bound up to 37 nmol of Cu per mg (dry weight). A highly purified exopolysaccharide preparation bound up to 253 nmol of Cu per mg of carbohydrate. The conditional stability constant for the crude exopolymer-Cu complex was 7.3 x 10 to the 8th power. This value was similar to those obtained for Cu complexes formed with humic acids and xanthan, an exopolysaccharide produced by Xanthomonas campestris. Studies conducted at copper concentrations, pHs, and temperatures found in sediments from which the bacterium was isolated indicated that the exopolymers were capable of binding copper under natural conditions. (Author's abstract)
W85-06144

INTERACTION OF ACETOGENS AND METHANOGENS IN ANAEROBIC FRESHWATER SEDIMENTS,
Freshwater Biological Association, Ambleside (England).
J. G. Jones, and B. M. Simon.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 944-948, April, 1985. 3 Fig, 3 Tab, 23 Ref.

Descriptors: *Anaerobic conditions, *Lake Sediments, *Bacterial metabolism, *Blelham Tarn, *England, *Acetogenic bacteria, *Methanogenic bacteria, Interstitial water, Sediments.

Anaerobic decomposition processes in the profundal sediments of Blelham Tarn (English Lake Dis-

trict) are often limited during late summer by the input of organic carbon. The concentration of acetate in the interstitial water fell from about 100 microM (immediately after sedimentation of the spring diatom bloom) to a relatively constant value of about 20 microM in late summer, during which acetate utilization appeared to be balance by production. Addition of chloroform and molybdate caused an accumulation of cold acetate in large sediment cores and of (C-14)acetate in small cores to which (C-14)bicarbonate had been added. In both cases chloroform caused the greater accumulation, implying that acetoclastic methanogens were the more active consumers. The conversion of labeled CO2 to (C-14)acetate was inversely related, with depth, to its conversion to labeled CH4. Methanogenesis from CO2 decreased during late summer, whereas acetogenesis and acetoclastic methanogenesis increased over the same time period. The production of acetate from CO2 was generally equivalent to less than 10% of the acetate carbon utilized but could be as high as 25% of that value. Hydrogen consumption by acetogens could be as high as 50% of that utilized in methanogenesis. The role of acetogenic bacteria in anaerobic processes may therefore be of greater significance in lakes such as Blelham Tarn than in more eutrophic systems. (Author's abstract)
W85-06146

2I. Water In Plants

MECHANISTIC SIMULATION ANALYSIS OF WATER USE, LEAF ANGLES, AND GRAZING IN EAST AFRICAN GRAMINOIDS,

Syracuse Univ., NY. Biological Research Labs.
M. B. Coughenour.
Ecological Modelling, Vol. 26, No. 3/4, p 203-230, December, 1984. 9 Fig, 5 Tab, 66 Ref.

Descriptors: *Simulation analysis, *Water use, *Leaves, *Grazing, *Grasslands, *Africa, Model studies, Photosynthesis, Plant morphology, Plant physiology, Transpiration, Vegetation.

A simulation model was constructed in order to interrelate the effects of defoliation by large mammalian herbivores with growth, photosynthesis, water use and light interception of representative graminoid vegetation from East Africa. Abiotic submodels describing water flows, light penetration and interception, and energy balance relationships were interfaced with a graminoid growth model that was specifically designed to examine grazing responses. Defoliation reduced rainfall interception and reduced transpiration, thereby increasing soil and plant water levels. Morphological adaptations made compensatory shoot growth possible, but grazing effects on plant water contents largely determined the degree of compensatory growth. Above-ground productivities were greatest at moderate grazing intensities while below-ground productivities were greatest at lower grazing intensities. The success of a given water use strategy depended on simultaneous consideration of the abiotic environment and grazing. Under frequent grazing soil water conservation and reduced shoot/root ratio counteracted the depletion effect of high stomatal conductance on plant water content. Consequently photosynthesis under frequent grazing was maximized by higher stomatal conductance. Canopy geometry was adaptive for maximal light harvesting subject to the constraints imposed by transpiration, water availability, and herbivory. Total photosynthesis was increased by erect leaf angles for tall but not short grasses. For frequently grazed short-grasses the benefits of prostrate leaves associated with escape from grazing exceeded the associated costs of reduced photosynthate. (Author's abstract)
W85-05870

WATER TRANSFER FROM SOIL THROUGH PLANTS TO THE ATMOSPHERE IN WILLOW ENERGY FOREST,

Sveriges Lantbruksuniversitet, Uppsala. Energy Forestry Project.
P. J. Kowalik, and H. Eckersten.
Ecological Modelling, Vol. 26, No. 3/4, p 251-284. December, 1984. 11 Fig, 117 Ref.

Descriptors: *Transpiration, *Forests, *Simulation analysis, *Model studies, Vegetation, Canopy, Soil water potential, Air temperature, Solar radiation, Leaf water potential, Willow.

A new continuous simulation model for transpiration from energy forest was formulated and solved numerically: the model describes interrelations of water state and transpiration in the soil-plant-atmosphere system under realistic field conditions and specifically includes the water stored in the plant. In the well-known Penman-Monteith method for transpiration determination, the surface temperature and humidity are eliminated by combining the bulk aerodynamic and heat budget relationships. In the method proposed here, the surface values are not eliminated but are computed by an iterative method, using empirically established stomatal resistance for the considered type of vegetation. Driving input variables (continuously recorded) are air temperature and relative humidity, solar radiation and soil water potential. Input also includes the values of aerodynamic resistance and plant liquid water resistance as well as time-invariant relations between leaf water potential and plant water content, stomatal resistance and leaf water potential, stomatal resistance and solar radiation, and soil-root hydraulic resistance and soil water potential, respectively. The simulation runs with a fixed time interval of 1 min. The model describes the changes in the diurnal course of transpiration, stomatal behavior, leaf water potential and leaf canopy temperature of willow plantations. The calculated daily cumulative values of transpiration (including evaporation of intercepted water) compared well with measured values observed in lysimeters in Salix stands at Studsvik (Sweden). The model has wider application than simply for willow; a change in the computer simulation from one plant species to another may be achieved by altering the root, xylem and leaf parameters of the model. (Author's abstract)
W85-05871

COMPARISONS OF FLOODING TOLERANCE IN FOUR BARLEY CULTIVARS (HORDEUM VULGARE) GROWN IN FINLAND, AND IN CAREX ROSTRATA,

Helsinki Univ. (Finland). Dept. of Botany.
K. Fagerstedt.
Annales Botanici Fennici, Vol. 21, No. 4, p 292-298, 1984. 1 Fig, 1 Tab, 23 Ref.

Descriptors: *Barley, *Flooding, *Sedges, *Plant physiology, Vegetation, Flood tolerance, Chlorophyll, Enzymes.

Four Finnish barley cultivars (Hordeum vulgare L. cvs. Hankkija-673, Pokko, Kustaa, and No. 59) and Carex rostrata Stokes were grown in sand culture in flooded conditions. When the flooding had lasted 0, 5, 10 and 15 days, root samples were taken for measurements of alcohol dehydrogenase (ADH) and glucose-6-phosphate dehydrogenase (G6-PDH) activity, and leaves for chlorophyll determinations. In all the barley cultivars the ADH activity was higher in the flooded plants than in the controls. In C. rostrata no changes occurred in ADH activity. The G6-PDH activity remained at the same level in the barely cultivars throughout the flooding period. The flooded barely seedlings rapidly developed chlorosis; in contrast the chlorophyll content of the oldest leaves of C. rostrata increased somewhat during the experiment in both the flooded and control plants. The results agree with Crawford's metabolic theory on flooding tolerance. The reasons for chlorosis in the leaves and flooding injury in the roots are discussed. (Author's abstract)
W85-05874

WATER USE EFFICIENCY OF NARROW ROW COTTON,

Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
For primary bibliographic entry see Field 3F.
W85-05918

PROLINE ACCUMULATION IN THE GRAINS, FLORAL ORGANS AND FLAG LEAVES OF WHEAT AND BARLEY IN RESPONSE TO VARIATIONS IN WATER AND NITROGEN SUPPLY,

Waite Agricultural Research Inst., Glen Osmond (Australia). Dept. of Plant Physiology.
D. Aspinall, K. V. M. Parameswaran, and R. D. Graham.
Irrigation Science, Vol. 4, No. 3, p 157-166, August, 1983. 1 Fig, 5 Tab, 17 Ref.

Descriptors: *Water stress, *Proline, *Wheat, *Barley, *Nitrogen, Plant growth, Drought, Plant water relations, Leaves, Grain, Water potential.

In wheat plants grown at two levels of water supply and three levels of nitrogen supply, proline accumulation in flag leaves and ears was enhanced by low water potential. Proline was increased by the presence of nitrogen through its effects on water potential. There were marked differences between two cultivars under study. With the ears of both wheat and barley a considerable discontinuity existed in accumulation of proline under stress. While the maternal tissues accumulated high concentrations of proline under stress, very little increase was found in the grain. This partitioning occurred also in excised ears, and so was independent of the rest of the plant; nor was it dependent on in situ synthesis of the respective tissues alone, since exogenous L-proline was also distributed in the same way. Some exogenously supplied DL-proline however, did enter the grain. Grain proline content was not maintained at a low level due to proline incorporation into protein. The significance of these results is discussed in relation to the evidence that wheat plants under water stress nevertheless maintain a high water potential in the grain. (Baker-IVI)
W85-05919

WATER UPTAKE OF BARLEY ROOTS FROM RHIZOSPHERIC SOIL SOLUTIONS OF DIFFERENT SALT CONCENTRATIONS,

Technische Univ., Brunswick (Germany, F.R.). Leichtweiss Inst. for Water Research.
U. Schleiff.
Irrigation Science, Vol. 4, No. 3, p 177-189, August, 1983. 8 Fig, 19 Ref.

Descriptors: *Soil water, *Salinity, *Rhizosphere, *Barley, Absorption, Roots, Transpiration, Saline soils, Osmotic potential, Soil solution, Plant growth.

Results of a simple method to obtain data on the root uptake of soil water from rhizospheric soil solutions differing in salt concentrations are presented. Some parameters of the shoots are presented in order to relate their growth potential in the osmotic potential of the rhizospheric soil solution. Restricted water availability is the main growth limiting factor in saline soils. The water supply of the shoot from a saline soil solution is a very complex process. It is suggested that there are two essential mechanisms involved in the water uptake of a root system, neither of which have been elucidated quantitatively as yet. First, nonrhizospheric soil solution moves into the rhizosphere, from where the soil water is taken up by the roots leaving behind most of the translocated salts in the rhizospheric soil solution. Simultaneously other roots grow into nonrhizospheric soil, which contains soil solution of low salt concentrations. Thus salt tolerance and total water uptake of a root system from a saline soil are essentially affected by two factors: the ability of a root to absorb soil water from rhizospheric soil solutions of decreasing osmotic potentials and the expansion of a root system in order to utilize soil solution of low salt concentrations from outside the rhizosphere. From the results of this experiment one can estimate the effect of increasing salt concentration in the rhizospheric soil solution on the water uptake by roots of a salt tolerant plant. A plant of lower salt tolerance such as maize did not depress the osmotic potential of its rhizospheric soil solution below -0.9 MPa. In contrast to maize, barley roots reduced the value to less than -2.5 MPa. From a soil solution of -0.9 MPa, when roots of young maize plants ceased their water uptake, the water uptake rate of barley roots was only slightly reduced. (Baker-IVI)

W85-05920

EFFECT OF SODIUM AND BICARBONATE IRRIGATION WATERS ON SODIUM ACCUMULATION AND ON MAIZE AND WHEAT YIELDS IN NORTHERN INDIA,
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils.
M. S. Bajwa, G. S. Hira, and N. T. Singh.
Irrigation Science, Vol. 4, No. 3, p 191-199, August, 1983. 4 Fig, 7 Tag, 12 Ref.

Descriptors: *Sodium, *Bicarbonate, *Irrigation water, *Crop yield, *Corn, *Wheat, *India, Salinity, Plant growth, Irrigation effects, Hydrogen ion concentration, Electrical conductivity, Saline soils, Infiltration rate, Gypsum, Saline water.

The effect of five years use of irrigation water containing sodium and bicarbonate on sodium accumulation in soils and yields of maize ahd wheat was studied in pots embedded in trenches in the field. Differences in irrigation water quality were significantly reflected in pH and electrical conductivity of soils throughout the depth. Nagar soil retained twice as much Na and Cl as Tulewal soil. Clay content and CEC on Nagar soil were double that of Tulewal sandy loam. Final water infiltration rates in Tulewal soil were about twice that compared with Nagar loam. Higher infiltration rate and low water retention capacity of coarse textured soil resulted in displacing the salts to deeper depths from where their redistribution to surface was limited as compared with the finer textured soil. Gypsum application reduced the pH and the ESP of both soils. In comparison with canal water, the ESP of soil receiving sodium water was high even after gypsum treatment. Pooled analysis of data for five years showed that maximum yields for maize fodder and wheat were obtained with canal water. Increase in salt concentration, sodium adsorption ratio, and residual sodium carbonate of irrigation water significantly reduced maize fodder yield. Simultaneous application of gypsum and salt-treated water significantly increased maize yield as compared with salt water alone but the yields were still significantly lower than those obtained with canal water. Single application of gypsum on cumulative basis showed less improvement in soil properties as well as in maize-fodder yield. Application of 50% extra depth of irrigation water over and above the evapotranspiration needs also increased maize fodder yield. Wheat yields were not significantly affected by any of these waters. (Baker-IVI)
W85-05921

MICROCLIMATE AND CROP RESPONSES TO CENTER PIVOT SPRINKLER AND TO SURFACE IRRIGATION,
Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
For primary bibliographic entry see Field 3F.
W85-05922

CHLOROPHYLL FLUORESCENCE INDUCTION: A SENSITIVE INDICATOR OF WATER STRESS IN MAIZE PLANTS,
Universite Libre de Bruxelles (Belgium).Lab. de Physiologie Vegetale.
M. Havaux, and R. Lannoye.
Irrigation Science, Vol. 4, No. 2, p 147-151, June, 1983. 1 Fig, 19 Ref.

Descriptors: *Chlorophyll, *Fluorescence, *Corn, *Water stress, Indicators, Drought, Leaves, Chloroplasts.

When green plants are illuminated they fluoresce. Upon a dark-light transition, the fluorescence yield shows several transients. This chlorophyll fluorescence induction phenomenon is a sensitive indicator for photosynthetic processes. Measurements of chlorophyll fluorescence provide a rapid and sensitive means of following the onset of drought injury in maize plants. In maize submitted to water stress sufficient to dehydrate leaves to 68% of original water content, a drastic reduction of the maximum to the minimum chlorophyll fluorescence ratio and strong inhibition of the slow fluorescence induction transients were noted. The maximum/minimum ratio value and the typical PSMT induction sequence were restored following the removal of drought conditions. Irreversible damage on the chloroplastic membranes was evidenced by the fact that the slow quenching of chlorophyll fluorescence to the steady state remained noticeably altered. This method could be valuable for rapid detection of drought injury in the field by using a portable fluorometer. (Baker-IVI)
W85-05931

DIURNAL CHANGES IN THE WATER RELATIONS AND TRANSPIRATION OF A SOYBEAN CROP SIMULATED DURING THE DEVELOPMENT OF WATER DEFICITS,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
P. J. Kowalik, and N. C. Turner.
Irrigation Science, Vol. 4, No. 4, p 225-238, December, 1983. 7 Fig, 36 Ref.

Descriptors: *Soybeans, *Diurnal variation, *Transpiration, *Simulation, *Water deficit, Plant water potential, Leaves, Leaf temperature, Mathematical models, Stomatal resistance, Water storage.

A mathematical model was developed to describe the changes in the diurnal patterns of leaf water potential and transpiration when a crop is exposed to increasing water deficits in the field. The model specifically includes the water stored in the plant. The model was developed for soybeans but could be extended to other crops with the substitution of suitable parameters. Feedback relationships are described for leaf temperature, transpiration, stomatal resistance, leaf water potential and amount of water stored in the plant. The calculated values of leaf water potential and transpiration compared well with measured values observed during the development of water deficits in a soybean crop growing on a grey cracking clay soil. The model should prove beneficial in refining and making models for irrigation scheduling more useful. (Moore-IVI)
W85-05932

EFFECT OF WATER STRESS AT THREE GROWTH STAGES ON THE YIELD AND WATER-USE EFFICIENCY OF DWARF WHEAT,
Haryana Agricultural Univ., Hissar (India). Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W85-05933

WATERLOGGING OF CONTAINERIZED RABBITEYE BLUEBERRIES IN FLORIDA,
Florida Univ., Gainesville. Dept. of Fruit Crops.
F. S. Davies, and D. Wilcox.
Journal of the American Society of Horticultural Science, Vol. 109, No. 4, p 520-524, July, 1984. 3 Fig, 4 Tab, 21 Ref.

Descriptors: *Flooding, *Plant growth, *Blueberries, *Florida, Soil properties, Temperature effects, Abaxial diffusive resistance, Flooding stress, Leaves, Containerized plants.

Attempts were made to determine what effects flooding had at various times during the season on growth and survival of rabbiteye blueberry, to test if abaxial diffusive resistance (ADR) of the leaf is an accurate indicator of flooding stress, and to compare the extent of damage in native soils compared with a peat:pine bark mixture commonly used in the production of containerized blueberies. Woodward plants survived 26 days of flooding with little shoot damage, but regrowth was severely impaired for the next 15 weeks. Leaf ADR of flooded Woodard rabbiteye blueberry plants was significantly greater than for nonflooded plants after 7 days of flooding and remained so over the course of the experiment. Attainment of maximum ADR was not an accurate indicator of plant survival since all plants lived. Woodward plants flooded from May to July survived as long as 58 days of flooding, but plants were severely damaged. Root resistance contributed significantly to ADR of flooded plants. ADR decreased about 80% within 30 min of root excision and became stable after 1 hr, while ADR of nonflooded plants did not change with excision. ADR was significantly greater for flooded plants in peat:pine bark than for those in Leonfine sand beginning 7 days after flooding. ADR was comparable for both soil types after 21 days of fooding. Developmental stage or cultivar seemed to have less effect on ADR than soil temperatures. An increase in ADR was a good indicator of short term flooding damage and cessation of shoot growth, but not of survival. Shoot growth of plants growing in native soil was affected less by flooding than that in a peat:pine bark mixture, although survival time was unaffected. Consequently, soil type should be considered when making flooded comparisons within and among species. (Baker-IVI)
W85-06059

CROP MOISTURE STRESS ANALYSIS USING COMPUTER-CONTROLLED ENVIRONMENTAL CHAMBERS AND SIMULATED WEATHER SEQUENCES,
Nebraska Univ.-Lincoln. Inst. of Agriculture and Natural Resources.
G. E. Meyer, J. A. Lamb, and W. E. Splinter.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 7, p 1862-1870, November-December, 1984. 9 Fig, 3 Tab, 29 Ref.

Descriptors: *Moisture stress, *Data interpretation, *Environmental chambers, *Weather, *Crop yield, Corn, Soybeans, Crop production, Water use efficiency.

Computer-controlled environmental plant growth chambers (PGC) were used to measure responses of water stressed and non-stressed corn and soybeans to simulated weather sequences. Simulated weather was patterned after actual hourly environmental conditions measured during a previous summer with a CR-21 weather station. Seasonal and diurnal crop water use in the PGC was controlled and monitored with an electronic lysimeter and a second computer system. Seasonal crop phenological responses were measured and show a remarkable pattern of stages of growth similar to field plants. 'LAST DAY' measurements of seed dry matter and seed number gave from 15.0 to 20.1 g per 100 seed and from 5 to 60 fruits per plant for soybeans. The PGC can be used to elicit the upper and lower limit growth responses to moisture-stress for certain crops. (Author's abstract)
W85-06097

EFFECTS OF SOIL BULK DENSITY AND WATER REGIMEN ON ROOT GROWTH AND UPTAKE OF PHOSPHORUS BY RYEGRASS,
University of New England, Armidale (Australia). Dept. of Agronomy and Soil Science.
For primary bibliographic entry see Field 2G.
W85-06098

WATER USE EFFICIENCY OF WHEAT IN A MEDITERRANEAN-TYPE ENVIRONMENT. II SOME LIMITATIONS TO EFFICIENCY,
South Australia Dept. of Agriculture, Adelaide.
R. J. French, and J. E. Schultz.
Australian Journal of Agricultural Research, Vol. 35, No. 6, p 765-775, 1984. 3 Fig, 2 Tab, 41 Ref.

Descriptors: *Water use efficiency, *Wheat, *Crop yield, *Nutrient requirements, Evaporation, Transpiration, Solar radiation.

Water use efficiency and yield of wheat were reduced by insufficient leaf area and by inadequate content of nutrients in the top growth. Yields from field trials were compared with the potential yield, and limitations caused by weeds, the incidence of diseases and the harvest index were reviewed. Crop production is governed by the interception of radiant energy and the efficiency of converting this energy to dry matter. In the early growth stages, the interception is limited by the leaf canopy, and it is not until a leaf area index (LAI) of about 3 has been obtained that the crop starts producing dry matter efficiently. Average values for nutrient content of plant tops at different stages of growth

were measured for 31 sites. The maximum content of nutrient (except for potassium and chlorine) occurs close to the soft dough stage and the nutrient content at maturity is generally lower. Maximum nitrogen content is related to water use; after the soil evaporation value of 110 mm, the efficient crops take up 0.65 kg/ha nitrogen for each mm of water transpired. Rates of accumulation of nutrients in the top growth to give maximum yield of dry matter per mm water transpired indicate that to produce the potential yield of 55 kg/ha dry matter (and 20 kg/ha grain) per mm water transpired, the crop needs to take up either by mass flow or diffusion, 0.65 kg/ha nitrogen and 0.07 kg/ha phosphorus for each mm water transpired. The data highlight the need for field experiments to define the evaporation and transpiration components of water use in each environment. They also indicate the need for multi-factorial treatments to overcome all yield limitations and thereby attain the potential yield. (Collier-IVI)
W85-06100

EFFECTS OF WATER STRESS ON INTERNAL WATER RELATIONS OF APPLE LEAVES,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Biologia.
L. Fanjul, and P. H. Rosher.
Physiologia Plantarum, Vol. 62, No. 3, p 321-328, November, 1984. 6 Fig, 3 Tab, 47 Ref.

Descriptors: *Apple trees, *Trees, *Water stress, *Plant physiology, Leaves, Drought, Stress, Sugars.

The capacity of apple (Malus pumila Mill. cv. James Grieve and Golden Delicious) pot- and orchard-grown trees to adjust osmotically in response to drought was investigated. Stressed leaves exhibited alterations in the moisture release curves when compared to well hydrated control leaves. Results suggest that osmotic adjustment occurred in both field- and pot-grown trees. Water potential for zero turgor was lowered by 0.5 MPa in leaves of potted trees and by 1.1 MPa in leaves of field-grown trees as a result of stress treatments. A decrease in the osmotic potential was responsible for that adjustment allowing the leaf to maintain turgor at lower water potentials and relative water contents. The extent of adjustment was similar for both potted and orchard trees despite the difference in the rate of stress imposition and its intensity. Changes in the concentration of sugars apparently contributed to this adjustment. (Author's abstract)
W85-06103

TRIADIMEFON REDUCES TRANSPIRATION AND INCREASE YIELD IN WATER STRESSED PLANTS,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
R. A. Fletcher, and V. Nath.
Physiologia Plantarum, Vol. 62, No. 3, p 422-426, November, 1984. 5 Fig, 3 Tab, 12 Ref.

Descriptors: *Fungicides, *Water stress, *Crop yield, *Transpiration, Wheat, Peas, Soybean, Triadimefon, Radish.

Two-week-old wheat (Triticum aestivum L. cv. Fredrick), peas (Pisum sativum L. cv. Little Sweetie) and soybean (Glycine max L. cv Hodgson) seedlings were transferred to paper cups containing various concentrations of triadimefon (1-(4-chlorophenoxy)-3,3 dimethyl-1 (1H-1,2,4-triazol-1-yl)-2 butanone) a fungicide. Twelve days after treatment, triadimefon (20 micro g/ml) significantly reduced transpiration in wheat, peas and soybeans by 40, 29 and 19%, respectively. The reduction of transpiration prevented the leaves from wilting and becoming senescent. In another experiment, triadimefon was applied as a soil drench after the initiation of flowers in soybeans and peas and after swelling in radish (Raphanus sativus L. cv, Cherry Belle) roots. After treatment the water level was maintained at half field capacity. In all three species, the treated plants were shorter, more compact and had thicker and greener leaves than the control plants. In the case of radish, the treatment also prevented flowering. Triadimefon significantly increased the seed yield of soybeans and peas and the root to shoot ratio in radish. Hence root application of triadimefon reduces transpiration, protects plants, and increases yield under water stress conditions. (Author's abstract)
W85-06104

EFFECTS OF LOW CONCENTRATIONS OF O3, LEAF AGE AND WATER STRESS ON LEAF DIFFUSIVE CONDUCTANCE AND WATER USE EFFICIENCY IN SOYBEAN,
Boyce Thompson Inst. for Plant Research, Ithaca, NY.
P. B. Reich, A. W. Schoettle, and R. G. Amundson.
Physiologia Plantarum, Vol. 63, No. 1, p 58-64, January, 1985. 4 Fig, 3 Tab, 34 Ref.

Descriptors: *Ozone, *Leaves, *Water stress, *Soybean, *Water use efficiency, Irrigation, Stomata, Plant tissues.

Ozone, leaf age and water stress each affected leaf conductance in soybean (Glycine max (L.) Merr. Hodgson), but there were no interactions among these factors. Exposure to increased concentrations of O3 (0.01, 0.05, 0.09, and 0.13) resulted in linear declines in abaxial and adaxial conductances in leaves of all ages. There were no differences in relative response to O3 between the two leaf surfaces. For well-watered plants, water use efficiency also decreased with exposure to increased O3 concentrations (water-stressed plants were not tested). Abaxial conductance increased as leaves aged from 4 to 10 days and then declined with further aging. Adaxial conductance decreased with all increases in leaf age beyond 4 days, and the ratio of abaxial/adaxial conductance increased continuously throughout the leaf lifespan. During water-stress cycles (water withheld for 2-3 days) leaves of water-stressed plants had lower conductances than those from well-watered plants, and there was no difference in relative response between abaxial and adaxial stomata. (Author's abstract)
W85-06105

INTERDEPENDENCE OF GROWTH, WATER RELATIONS AND ABSCISIC ACID LEVEL IN PHASEOLUS VULGARIS DURING WATERLOGGING,
Utrecht Rijksuniversiteit (Netherlands). Botanical Lab.
H. Wadman-van Schravendijk, and O. M. van Andel.
Physiologia Plantarum, Vol. 63, No. 2, p 215-220, February, 1985. 5 Fig, 33 Ref.

Descriptors: *Plant growth, *Abscisic acid, *Beans, *Water potential, Plant physiology, Transpiration, Diffusion resistance, Flooding.

The interdependence between changes in growth and water relations after waterlogging was investigated by recording simulaneously growth, transpiration, water potential, turgor, leaf diffusion resistance and abscisic acid content in Phaseolus vulgaris L. cv. bruine Noord-Hollandse. Growth was inhibited immediately after flooding, whereas transpiration decreased gradually to a low level in about three days. The first two days after flooding a small increase in abscisic acid content in the leaves was observed which accompanied by an increase in diffusion resistance. The increase in abscisic acid content could result from an inhibited export from the leaves. After the first two days a decrease in water potential and turgor was accompanied by a drastic increase in both abscisic acid content and diffusion resistance. This large increase in abscisic acid content occurred before the turgor had reached its minimum value. The change in diffusion resistance kept showing a lag of about one day with the change in abscisic acid content. The possibility is discussed that besides abscisic acid also its metabolite phaseic acid is involved in stomatal closure. After the formation of adventitious roots on the hypocotyl, abscisic acid level, diffusion resistance, water potential and turgor returned to the control values. Transpiration showed a slow recovery from the sixth day after flooding, whereas growth was inhibited for at least nine days. A remarkable similarity exists between our observations on the responses of bean plants to flooding and the well known responses to drought. (Author's abstract)
W85-06106

EFFECTS OF SINGLE AND MULTIPLE WATERLOGGINGS ON THE GROWTH AND YIELD OF WINTER WHEAT ON A CLAY SOIL,
Agricultural Research Council, Wantage (England). Letcombe Lab.
R. K. Belford, R. Q. Cannell, and R. J. Thomson.
Journal of the Science of Food and Agriculture, Vol. 36, No. 3, p 142-156, March, 1985. 5 Fig, 9 Tab, 34 Ref.

Descriptors: *Wheat, *Plant growth, *Soil water, *Waterlogging, *Clays, Oxygen, Population density, Nitrates, Nutrients, Crop yield.

The response of winter wheat to surface waterlogging in monoliths of clay soil in lysimeters was studied. The treatments, selected as corresponding to the most extreme likely in Britain, were: 5 days of waterlogging in October between germination and emergence; 42 days of waterlogging during tillering January and February; and 21 days from mid-April during stem elongation. These treatments were used singly and in all combinations and were compared with a freely-drained control. During waterlogging, the oxygen concentration in the soil declined most rapidly when the soil was warmer (in October and April) and at the shallower depths (5, 20 cm); also, a decrease in soil solution nitrate was accompanied by an increase in nitrous oxide evolution. Pre-emergence waterlogging restricted plant population to 35/sq m compared to 338/sq m under free drainage. Subsequently, compensatory growth resulted from diminished interplant competition for nitrogen, water and light; a greater proportion of tillers survived and the flag leaves were larger, although ears at harvest were fewer in all treatments waterlogged before emergence. After waterlogging during tillering, grain loss was accounted for entirely by a decrease in the number of ear-bearing tillers. After waterlogging during stem elongation, yield losses were associated primarily with fewer grains per spikelet. Grain yield was depressed by about 4-12% after single waterloggings, by 20% after any two waterloggings, and by 32% when plants were waterlogged on all three occasions. (Author's abstract)
W85-06136

MEASUREMENTS OF CANOPY INTERCEPTION AT THE ST. ARNOLD LYSIMETER STATION/MUNSTERLAND (DIE INTERZEPTIONSMESSUNGEN AN DER GROSSLYSIMETERANLAGE ST. ARNOLD),
Amt fuer Wasser- und Abfallwirtschaft, Muenster (Germany, F.R.).
M. Schroder.
Deutsche Gewasserkundliche Mitteilungen, Vol. 28, No. 5/6, p 164-171, December, 1984. 10 Fig, 9 Tab, 6 Ref.

Descriptors: *Interception, *Canopy, Evaporation, Precipitation, Forests, Grasslands, Water loss, Wetting capacity, Wetting loss.

An objective method is described for the determination of the wetting capacity and wetting losses (interception loss and interception evaporation) for particular precipitation events and daily precipitation totals and thus description of the relationships between net-supply rainfall in a forest area and open-land rainfall in an unwooded grassland area. These functions are of importance in calculating area-related water balances with corresponding temporal resolution. It appears to be necessary to introduce a characteristic index for forest crops, similar to the leaf area index, which can be efficiently used in determining the wetting capacity. Roughly estimated values for the net-supply rainfall in a forest area can be derived from the open-land rainfall on the basis of linear interrelations between these two precipitation amounts, calculated from monthly precipitation data. (Moore-IVI)

W85-06158

2J. Erosion and Sedimentation

RELATION BETWEEN THE COMPOSITION OF GRAVEL FRAGMENTS OF THE JIZERA RIVER AND THE GEOLOGY OF ITS BASIN (VZTAH MEZI SLOZENIM ULOMKU FLUVIALNICH SEDIMENTU JIZERY A GEOLOGICKOU STAVBOU JEJIHO POVODI),
Karlova Univ., Prague (Czechoslovakia). Dept. of Geology.
J. Plaminkova, and J. Plaminek.
Acta Universitatis Carolinae - Geologica, No. 4, p 297-309, 1983. 4 Fig, 2 Tab, 4 Ref.

Descriptors: *Jizera River, *Gravel, *Riverbeds, *Sediments, *Poland, Petrography, Geology, Sediment transport.

The petrographic composition of the fraction exceeding 1 cm in the fluviatile sediments of the river Jizera is closely associated with the geological structure of the drainage basin. The content of a material in a clastic sediment corresponds to the relation where the areal extent of the occurence of this material in its source area and the average length of its transport are considered. Curves were plotted expressing the ascertained contents of the individual materials contained in the river sediment. The departures of the expected from the real contents of these materials was evaluated and resistance to transport was determined. The results obtained on the basis of this method may be used (1) for the assessment of the quantities of the individual materials, based on study of fluviatile sediments in geologically unsufficiently explored areas, (2) for an assessment of the amounts and the petrographic composition of the gravels, based on an analysis of the geological structure of the drainage basin, in any place of the river, (3) for the reconstruction of the pre-recent geological structure of the basin, on the basis of studies of terrace sediments. (Author's abstract)
W85-05859

OFF-SITE COSTS OF SOIL EROSION,
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 5C.
W85-05941

SEDIMENT DEPOSITS IN DRAINAGE DITCHES: A CROPLAND EXTERNALITY,
Ohio State Univ., Columbus.
D. L. Forster, and G. Abrahim.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 141-143, January-February, 1985. 1 Tab, 8 Ref.

Descriptors: *Drainage ditches, *Sediment deposition, Ohio, Erosion control, Costs, Soil erosion, Soil conservation, Cropland.

Soil loss estimates have been used as a proxy for off-site costs, but the relationship between soil loss and off-site costs remains inexact. One externality of soil loss from cropland is sedimentation of drainage ditches. A study was conducted in six Ohio counties to determine the relationship between gross soil erosion estimates and actual sediment deposition in water bodies and to measure one of the downstream costs of soil loss, sediment removal from drainage ditches. Drainage ditch sediment deposits related significantly to gross soil erosion estimates calculated with the universal soil loss equation (USLE). Removal of the sediment cost an average of 45 cents per cropland acre served by the drainage ditches. This cost could be reduced nearly 25% with the use of common soil conservation practices. The results support the contention that gross erosion near water bodies causes more sediment deposition that distant soil erosion. It follows that conservation practices used in proximity to drainage ditches can effectively reduce sediment deposition. (Moore-IVI)
W85-05965

CHANNEL CROSS-SECTION CHANGES IN MISSISSIPPI'S GOODWIN CREEK,
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
J. B. Murphey, and E. H. Grissinger.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 148-153, January-February, 1985. 4 Fig, 2 Tab, 12 Ref.

Descriptors: *Channel morphology, *Bank erosion, *Goodwin Creek, *Mississippi, Lithology, Stream banks, Bed erosion, Sediment erosion, Slab failure.

Selected channel cross sections in a 3.86-km reach of Goodwin Creek in southeastern Panola County, Mississippi, were periodically resurveyed from November 1977 through June 1983. Rates of channel enlargement varied with bank and bed material lithology, but short-term changes were variable in time and space. Banks composed of early Holocene deposits were relatively stable; however, they failed in polygonal blocks after bank toe removal. Banks composed of late-Holocene deposits were more erodible, and gravity-induced slab failures followed loading and tension crack development. Within individual reaches, channel changes were highly variable. Average net erosion of the channel bed and banks over the 5 1/2-year period was about 21 tons of sediment from each meter of channel length in the reach. (Author's abstract)
W85-05967

PLANT NUTRIENT LOSSES BY SOIL EROSION AND MASS MOVEMENT AFTER WILDFIRE,
Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab.
J. D. Helvey, A. R. Tiedemann, and T. D. Anderson.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 168-173, January-February, 1985. 8 Fig, 6 Tab, 22 Ref.

Descriptors: *Fire, *Soil erosion, *Mass wasting, *Nutrients, *Washington, Sediment yield, Debris torrents, Suspended solids, Sediment transport, Nitrogen, Phosphorus, Calcium, Magnesium, Potassium, Sodium, Alluvial fans, Forest watersheds.

Annual sediment yields increased as much as 180 times above pre-fire levels after wildfire destroyed all vegetation on three forested watersheds in the Entiat Experimental Forest in the eastern Cascade Range of Washington. Sediment was transported in debris torrents, in suspension, and as bedload. Suspended sediment concentration correlated well with turbidity. Total N losses by erosion processes increased from a pre-fire average of 0.004 kg/ha/yr to 0.16 kg/ha/yr. Available P losses increased from 0.001 ka/ha/yr before the fire to 0.014 kg/ha/yr. The combined erosion loss of Ca, Mg, K, and Na increased from an average of 1.98 kg/ha/yr before the fire to 54.3 kg/ha/yr. Greatest nutrient losses occurred with mass soil movements (debris torrents). Material deposited in alluvial fans represented losses of 13.5 kg/ha of total N, 3.4 kg/ha available P, and 3,850 kg/ha of Ca, Mg, K, and Na combined. An unmeasured but certainly large quantity of soil and rock entered the river during the debris flows. Nutrient losses on eroded soil, although greater than solution losses, were insignificant to site productivity and stability compared with the physical effects of channel scouring associated with greater runoff, higher peak flows, and debris torrents following fire. (Author's abstract)
W85-05972

PARTICLE SIZE DISTRIBUTION, CHEMICAL COMPOSITION AND CALCULATION OF STANDARD MINERALOGICAL COMPOSITION OF SUSPENDED SEDIMENT TRANSPORTED BY A STREAM IN OKINAWA ISLAND,
Okinawa Inst. of Physicachemical Research, Okinawa City.
E. Tohyama.
Japanese Journal of Limnology, Vol. 45, No. 4, p 253-259, October, 1984. 2 Fig, 3 Tab, 23 Ref.

Descriptors: *Stream sediments, *Chemical composition, *Minerals, *Makiminato, *Okinawa, Sediment transport, Particle size, Suspended sediments, Clay, Silt, Sand.

Makiminato stream drains the central part of the Shimajiri marl area, which is situated in the southern province of Okinawa Island, and subsequently flows into the East China Sea. Suspended sediment delivered by Makiminato during a flood period consists of about 40% clay, 58% silt and 2% sand in terms of weight. The sediment, judging from its high Al2O3 content, can be classified as an argillaceous type. The chemical composition of the sediment is more analogous to that of terrigenous clay than red clay and nearshore marine clay. In comparison to the terrigenous clay, it is relatively low in SiO2 and significantly high in CaO which is traceable to the calcareous fossils within the Shimajiri formation and the Ryukyu limestones. The mineral composition of the sediment is calculated by recasting the chemical oxide components into standard minerals: plagioclase, K-feldspar, Ca-feldspar, calcite, dolomite, enstatite, anhydrite, chlorite, montmorillonite, kaolinite, illite, ilmenite, quartz and hematite. (Moore-IVI)
W85-05996

EFFECTS OF BENTHIC MACROINVERTEBRATES ON THE EXCHANGE OF SOLUTES BETWEEN SEDIMENTS AND FRESHWATER,
Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2K.
W85-06005

CHANNEL CHANGES AND INVERTEBRATE FAUNAS BELOW NANT-Y-MOCH DAM, RIVER RHEIDOL, WALES, UK,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W85-06007

WATER AND SEDIMENT ROUTING THROUGH CURVED CHANNELS,
San Diego State Univ., CA.
For primary bibliographic entry see Field 2E.
W85-06040

SCOUR AT CYLINDRICAL BRIDGE PIERS IN ARMORED BEDS,
Auckland Univ. (New Zealand).
A. J. Raudkivi, and R. Ettema.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 713-731, April, 1985. 10 Fig, 2 Tab, 7 Ref, 1 Append.

Descriptors: *Scour, *Piers, *Bridges, *Armored beds, Sediment erosion, Bed sediments, Hydraulic models, Model studies.

The depth of scour at a pier placed in a river bed covered by an armor layer of sediment that is coarser than the underlying bed sediment may significantly exceed that which occurs if the pier were placed in an unlayered bed. Laboratory experiments were conducted on the development of scour around a cylindrical pier placed in a bed a cohesionless sediment overlain by an armoring layer of coarser sediment. Both the armoring layer and the bed beneath it were composed of uniform-sized sediment. The presence of an armor layer can extend the clear water condition of local scour at a pier from the limit for the stability of the bed sediment to the stability limit for the armor layer covering the finer sediment. When the armor layer remains intact around the pier, a maximum equilibrium depth of local scour of about three times the effective pier width can result. The simultaneous development of the local scour around the pier and the localized bed scour, or armor-break scour can lead to a large number of equilibrium scour forms. There are two significant depths of scour pertaining to the scour of armored bed sediments in the vicinity of a pier: the total depth of scour measured at the pier, and the maximum depth of localized bed scour due to the erosion of the armor layer. (Moore-IVI)
W85-06042

DEBRIS FLOWS AND DEBRIS TORRENTS IN THE SOUTHERN CANADIAN CORDILLERA,
VanDine Geological Engineering Services, Victoria (British Columbia).
D. F. VanDine.
Canadian Geotechnical Journal, Vol. 22, No. 1, p 44-68, February, 1985. 17 Fig, 4 Tab, 86 Ref, 1 Append.

Descriptors: *Debris torrents, *Debris flows, *Mass wasting, British Columbia, Yukon, Alberta, Debris, Bridges, Flow discharge, Creeks, Slope, Check dams, Slope stabilization, Land use, Debris barriers.

In Canada, debris torrents (also referred to as channelized debris flows) occur in parts of British Columbia, Alberta, and the Yukon. At least 17 deaths and an estimated $100 million of damage to bridges and property can be attributed to this natural hazard. The debris mainly comprises large boulders, rock fragments, gravel- to clay-sized material, tree and wood mulch-materials that accumulate in the mountain creeks. To be susceptible to a debris torrent, a creek must have a drainage area within a critical range, a profile that is sufficiently steep, an accumulation of debris, and some form of triggering mechanism. The most common triggering mechanism is an extreme water discharge, which may result from a very intense rainfall or a temporary damming of the creek. In western Canada, the resulting torrents involve masses of debris, typically less than 50,000 cu m, that the travel down creeks at speeds between 3 and 12 m/s. Several passive and active forms of mitigation can be used to reduce the impact of debris torrents on creek crossings and neighboring residents. Passive mitigation methods include avoidance of the area, relocation of structures and facilities, land use restrictions, and some form of warning system. Active mitigation methods include remedial measures to remove or counter the causes, and various forms of designed protection. Constructing check dams near the headwaters of the creek and stabilizing the valley slopes that border the creeks are examples of remedial measures. Constructing debris barriers or clear span bridges with adequate clearance are examples of designed protection. Howe Sound, north of Vancouver, British Columbia, has had a relatively high number of debris torrents. Recently, several major studies have addressed the extent of the hazard and recommended mitigative measures for this area. Many of the examples presented in this paper are drawn from this case history. (Author's abstract)
W85-06044

NITROGEN AND PHOSPHORUS EXPORTATION IN THE GARONNE BASIN (FRANCE),
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
For primary bibliographic entry see Field 5B.
W85-06049

SOIL EROSION STUDY OF EXPOSED HIGHWAY CONSTRUCTION SLOPES AND ROADWAYS,
For primary bibliographic entry see Field 4D.
W85-06069

ROADSIDE EROSION CAUSES AND FACTORS: MINNESOTA SURVEY ANALYSIS,
R. Sullivan, and L. E. Foote.
Transportation Research Record, Vol. 948, p 47-54, 1984. 8 Fig, 1 Tab.

Descriptors: *Erosion, *Soil erosion, *Road construction, *Minnesota, Construction methods, Management planning.

A roadside erosion survey was conducted along all state, county, and township roads in Minnesota to identify and document the location and amount of erosion present. Roadside survey field work was conducted in the spring after snowmelt, but before extensive vegetation growth, or in the fall after growth had stopped and had been affected by frost. A total of 116,203,336 cu ft of erosion was distributed over 17,702 sites located along 115,570 miles of roadway. Erosion ranged from 20,894 to 23,444,632 (median: 521,681) cu ft per county and from 17 to 17,173 (median: 433) cu ft per mile. The average volume of soil lost per county was 1,335,728 cu ft, but only 15% of the counties had more than the average estimate. Specific causes of soil loss in counties with the most severe loss included lack of vegetative cover, rough terrain, use of roadsides as borrow areas, lack of erosion control during development, recreational activities, lack of past administrative emphasis on erosion control and repair, and lack of funds to correct existing problems. Occurrences of erosion per county ranged from 9 to 1,015 (median: 166), or one site every 8.3 miles. The average size of erosion occurrences ranged from 230 to 37,006 (median: 3,008) cu ft. The greatest volume of erosion was found on roadways built according to the cut-fill design; the lowest estimated volume of erosion was along the fill-design roads. Erosion occurred most frequently on at-grade roads: 40% of all occurrences noted by design were on at-grade roads. The most frequently noted location of erosion was ditch bottoms (30% of sites); loss of soil from adjacent areas and in-slopes accounted for 25% and 24%, respectively. The larger sites of erosion in Minnesota are generally caused by (1) inadequate design of roads, especially in areas of rough terrain or poor soils and near streams and rivers, and (2) lack of administrative direction and emphasis, especially in establishment of vegetative cover, maintenance repair of erosion sites, and control of unauthorized activities along the roadside, such as farming and use of the roadside for borrow or recreational purposes. (Rochester-IVI)
W85-06070

SCOUR AT CULVERT OUTLETS IN MULTIBED MATERIALS,
S. R. Abt, J. F. Ruff, and C. Mendoza.
Transportation Research Record, Vol. 948, p 55-62, 1984. 10 Fig, 4 Tab, 11 Ref.

Descriptors: *Scour, *River Beds, *Culverts, Sand, Gravel, Road construction, Erosion control.

Scour at culvert outlets was tested in two facilities using culverts ranging from 4-18 in in diameter. A uniform sand, a uniform gravel, a graded sand, a graded gravel, and a cohesive bed material, of residual Colorado expansive clay mixed with graded sand, were used. Test periods ranged from 316-1,000 min, and discharges ranged from 0.11-29.13 cu ft/sec. Scour holes observed after 75 scour tests with noncohesive materials were generally similar in geometric configuration and appearance: circular shapes prevailed at discharge intensity (DI) $<$ or $=$ 1, with elongation to an oval shape as DI exceeded 1. Scour holes formed in 12 tests with the cohesive SC soil showed the same relationship of shape to DI. Depth, width and length of scour holes, and volume of scour were correlated with bed materials, culvert, and discharge. Based on these relationships, equations were developed for estimating scour-hole dimensions at any finite time between 31 min and 316 or 1,000 min. Scour-hole dimensions in noncohesive materials reached approx 80% of the maximum after the initial 31 min of testing. The maximum scour depth was located at a point approx 0.3-0.4 times the maximum length of scour measured downstream of the culvert outlet. A headwall placed adjacent to the culvert outlet in the cohesive materials tests had little effect on scour-hole dimensions. It did, however, protect the embankment from undermining as the scour-hole extended as far as 0.2 times its length into the embankment for the no-headwall condition. With the SC cohesive soil, 70% of the maximum scour-hole dimensions was obtained after the initial 31 min of testing. The maximum scour depth was located at a point approx 0.35 times the maximum length of scour measured downstream of the culvert outlet. With noncohesive materials, the length of the area affected by scour was approx twice the length of the scour hole, and the width was approx 2-3 times the width of the scour hole, for culverts flowing full. In another test circular-shaped culverts were shown to yield more conservative scour-hole dimensions than square-shaped culverts of similar characteristic lengths. (Rochester-IVI)
W85-06071

FREEZE-THAW AND CONSOLIDATION EFFECTS ON STRENGTH OF A WET SILT LOAM,
Soil Conservation Service, Portland, OR.
G. E. Formanek, D. K. McCool, and R. I. Papendick.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1749-1752, November-December, 1984. 2 Fig, 2 Tab, 16 Ref.

Descriptors: *Freeze-thaw, *Frost, *Erosion control, *Silt loam, *Strength *Consolidation, Soil erosion, Frozen ground, Soil water, Soil properties.

Freeze-thaw cycles of wet, silty soils in the Pacific Northwest result in low water intake and a surface layer with very low erosion resistance. The effect of cycles of freeze-thaw with high soil moisture on the shear strength of a thawed silt loam were quantified as were shear strength changes as the thawed soil loses water without desaturating (soil water tension less than air entry value). The cohesional strength of a wet silt loam soil from a tilled, continuous fallow plot was reduced from an original value of 0.9 kPa to 0.4 kPa by one cycle of freeze-thaw in the laboratory. The cohesion was measured with a fall-cone device. Additional cycles reduced strength only slightly. Soil water tensions of less than 9 kPa, applied after thawing, resulted in cohesion of about 2.4 kPa. The soil regained cohesion in proportion to the logarithm of the consolidating soil water tension. Practices that cause frost discontinuity, reduce the number of cycles of freeze-thaw, of cause consolidation result in increased erosion resistance and reduce the opportunity for erosion, such practices are a means of erosion control in the Pacific Northwest and other regions where freeze-thaw commonly acts on wet, silty soils. (Collier-IVI)
W85-06082

PROBABILISTIC MODELING OF SOIL LOSS FROM SURFACE MINED REGIONS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
K. B. Rojiani, K. A. Tarbell, V. O. Shanholtz, and F. E. Woeste.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1789-1804, November-December, 1984. 5 Fig, 4 Tab, 25 Ref.

Descriptors: *Soil loss, *Model studies, *Surface mining, *Probabilistic process, Statistical analysis, Erosion, Sediment transport, Rainfall.

A probabilistic model for predicting the soil loss from surface mined areas is presented. The method is based on a combination of statistical analysis and simulation. Distributions of random variables were obtained from a statistical analysis of available data. Distributions of sediment yield were determined by coupling probabilistic models of rainfall variables with a deterministic model of the sediment yield process. To illustrate the application of the procedure, probability distributions of the total soil loss over a period of three years were determined for two separate soil types and for conditions representative of actual mining operations. The effect of the number of trials and the seed value on the results of the simulation also was investigated. (Collier-IVI)
W85-06090

MATERIAL AND SITE CONTROLS OF STREAM BANK VEGETATION,
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
For primary bibliographic entry see Field 2E.
W85-06095

CASE HISTORIES OF SCOUR PROBLEMS AT BRIDGES,
For primary bibliographic entry see Field 8A.
W85-06107

OVERVIEW OF FACTORS AFFECTING RIVER STABILITY,

R. E. Trent, and S. A. Brown.
Transportation Research Record, Vol. 950, No. 2, p 156-163, 1984. 2 Fig, 1 Tab, 11 Ref.

Descriptors: *River beds, *Channel morphology, *Roads, Erosion, River mechanics, Sediment transport, Meanders.

Anticipating the potential for and recognizing the existence of channel instabilities is a critical aspect of locating and designing highways in river environments. Channel instabilities include oscillations in channel-bed elevation, variations in river orientation and location, and major river migrations or meanders. Factors affecting river stability have been classified as natural or accelerated. Natural instabilities result from changes in hydrometeorology whereas accelerated erosion is usually a result of man's activities within the watershed. Identifying channel instabilities requires an understanding of the geomorphic processes occurring within the watershed in question and an awareness of all activities that affect it. A thorough analysis of the stability of the river system should include consideration of past changes in the system and changes in progress, as well as a geomorphic analysis to predict future changes. (Collier-IVI)
W85-06108

ASSESSMENT OF CHANNEL STABILITY AT BRIDGES SITES,
For primary bibliographic entry see Field 8A.
W85-06109

EFFECT OF BRIDGE PIERS ON STREAMFLOW AND CHANNEL GEOMETRY,
For primary bibliographic entry see Field 2E.
W85-06110

USE OF SPURS AND GUIDEBANKS FOR HIGHWAY CROSSINGS,
For primary bibliographic entry see Field 8A.
W85-06111

COMPARISON OF PREDICTION EQUATIONS FOR BRIDGE PIER AND ABUTMENT SCOUR,
J. S. Jones.
Transportation Research Record, Vol. 950, No. 2, p 202-209, 1984. 9 Fig, 22 Ref.

Descriptors: *Predictions, *Mathematical equations, *Bridge piers, *Abutments, *Scour, Piers, Erosion, Sediment transport.

There are at least 10 prediction equations for bridge pier scour, and designers are often at a loss over which one to use. There are only three or four prediction equations for abutment scour, but these have not been highly publicized. The pier scour equations fall into three basic categories: those of the University of Iowa, those of the Colorado State University, and those based on foreign literature. The similarities among the pier scour equations and the range of data on which they are based are shown. FHWA sponsored several studies during the 1970's aimed primarily at comparing field data with the various equations to show which ones best predicted local scour for U.S. streams. These studies were somewhat inconclusive because of the many interrelated variables in the scour process, but they do show which equations are conservative and which are not. (Author's abstract)
W85-06113

RIPRAP STABILITY ANALYSIS,
M. A. Stevens, D. B. Simons, and E. V. Richardson.
Transportation Research Record, Vol. 950, No. 2, p 209-216, 1984. 9 Fig, 21 Ref.

Descriptors: *Riprap, *Stability analysis, *Stream flow, Erosion control, Bank protection, Design criteria.

In the absence of wave and seepage forces, the stability of rock riprap particles on a side slope is a function of the magnitude and direction of the stream velocity next to the particles, the angle of the side slope, and the characteristics of the rock, including the geometry, angularity, and density. A method of designing riprap was developed based on a functional relation among the variables. Rock particles on side slopes tend to roll rather than slide. Therefore, it is appropriate to consider the stability in terms of moments about a point of rotation. The functional relation has its basis in the balance of moments about a point of rotation at incipient motion between the forces trying to move the particle and the forces resisting movement. A safety factor was developed that is the ratio of the resisting moments tending to move the particle of riprap. This safety factor takes into consideration the side slope of the bank being protected; the size, density, and angle of repose of the rock; and the lift and drag forces of the following water. The method is described, examples of its use are given, and it is compared with other methods developed by the Bureau of Public Roads, U.S. Army Corps of Engineers, California Division of Highways, Bureau of Reclamation, the ASAE Task Committee on Sedimentation, and others. (Author's abstract)
W85-06114

ANALYSIS OF COMMONLY USED RIPRAP DESIGN GUIDES BASED ON EXTENDED SHIELDS DIAGRAM,
H. W. Shen, and S.-Y. Wang.
Transportation Research Record, Vol. 950, No. 2, p 217-221, 1984. 6 Fig, 2 Tab, 19 Ref.

Descriptors: *Riprap, *Design criteria, *Shields diagram, *Bank protection, Shore protection, Sediment transport, Rocks.

River and coastal engineers are often faced with the task of selecting the appropriate riprap size for bank protection. Several empirical formulae based on field and laboratory tests have been suggested for selecting the maximum size and gradation size distribution of the riprap. To facilitate riprap size selection, several commonly used riprap design guides presented by the U.S. Army Corps of Engineers (for shore protection), the U.S. Bureau of Reclamation (for bank protection), and the California Department of Transportation (for both shore and bank protection) as well as guides from projects sponsored by the FHWA (for energy dissipators related to both culverts and channels) are analyzed. It is found that all these design guides are compatible and agree with the extended Shields incipient motion diagram for large sediment sizes. (Author's abstract)
W85-06115

COMPUTER-BASED PREDICTION OF ALLUVIAL RIVERBED CHANGES,
F. M. Holly, T. Nakato, and J. F. Kennedy.
Transportation Research Record, Vol. 950, No. 2, p 229-237, 1984. 4 Fig, 27 Ref.

Descriptors: *Computer models, *Alluvial channels, *River beds, Model studies, Channel morphology, Sediment transport, Numerical analysis.

The sheer expense and space requirements of physical scale models generally disqualify them for simulation of long-term, large-distance riverbed reponse to the second type of perturbation. For these purposes, numerical, computer-based models, which can simulate both short- and long-term response, find their natural area of application. Recent investigations and research programs at the Iowa Institute of Hydraulic Research have involved both the analysis and development of computer-based simulation techniques for alluvial riverbed evolution. The primary use of such techniques is in the prediction of riverbed aggradation and degradation caused by perturbations in the river's equilibrium geometry and sediment inflow supply over extended reaches. The mathematical problem can be reduced to one of solving just a nonlinear partial-differential system in each time interval over which the water discharge is assumed to be nonvarying in time, be it for several hours during a rising flood hydrograph or several years if the effects of a single dominant discharge are of interest. No computer models presently available incorporate a general, adequate treatment of sorting and armoring processes. Nevertheless, some models attempt to simulate their effects on bed evolution; others ignore them completely. Another important distinguishing feature of computer-based models is the degree to which they incorporate sorting and armoring effects. The most important overall need is for better interpretation of physical processes and their incorporation in the numerical models. Numerical techniques for solution of the governing equations are now adequately developed for accurate prediction of alluvial river bed profiles if an accurate sediment-transport function and a bed-roughness predictor were available. (Collier-IVI)
W85-06117

MODELING GENERAL SCOUR AT BRIDGE CROSSINGS,
H. H. Chang.
Transportation Research Record, Vol. 950, No. 2, p 238-243, 1984. 8 Fig, 13 Ref.

Descriptors: *General scour, *Scour, *Bridge crossings, *Piers, *Model studies, Local scour, Sediment transport, Water surface profiles.

Local scour that occurs around bridge piers and abutments is caused by local obstructions to flow. General scour refers to the change in river-channel configuration provoked by sediment imbalance, due to natural or man-made factors. Because general scour at bridge crossings is related to the flow and sediment-transport processes of the adjacent river as a system, evaluation of such scour requires modeling of the river channel for water and sediment routing. General scour at bridge crossings was modeled using a mathematical model for water and sediment routing. For a given bridge configuration, general scour that results from imbalance in sediment supply and transport capacity of the river was evaluated based on river channel evolution reflecting the flow and sediment-transport processes. A river's adjustment in width in relation to power expenditure may also be explained based on the water-surface profile. If the energy gradient is approximated by the water-surface slope, the equal energy gradient is equivalent to the straight water-surface profile. A river reach undergoing changes usually has an uneven water-surface profile, but it constantly seeks to establish a straight profile through adjustments in channel geometry, roughness, and so forth subject to physical constraints such as abutments, rigid banks, and check dams. In the present model, the channel geometries are adjusted, subject to the constraints, so that they favor uniformity in the water-surface profile. Two case studies are presented, on the Santa Margarita River and on the San Dieguito River (California), to illustrate the prediction of general scour caused by man-made factors including sand mining and flow constriction by a bridge. Depth of general scour was found to be sensitive to channel width; therefore, width formation of the alluvial river plays an important role in scour development. (Collier-IVI)
W85-06118

MATHEMATICAL MODEL FOR ESTIMATING SCOUR THROUGH BRIDGE CROSSINGS,
D. B. Simons, R.-M. Li, and G. K. Cotton.
Transportation Research Record, Vol. 950, No. 2, p 244-251, 1984. 5 Fig, 9 Ref.

Descriptors: *Mathematical models, *Scour, *Bridge crossings, Model studies, River beds, Channel morphology, Hydraulics, Erosion.

Changes in bed level in alluvial channels are an important design consideration for bridge crossings. The general problem of scour at bridge crossings involves degradation, aggradation, and local scour. Three types of interrelated scour phenomena are found at bridges: (a) local scour caused by piers and abutments disturbing the flow, forming vortices and eddies; (b) scour due to contraction of the flow at the crossing, causing increased velocities in the contracted width; and (c) degradation or aggradation of a stream channel over relatively long reaches and over a long time due to bed-level

controls, changes in sediment supply, and changes in river form. A model of these scour phenomena has been developed by Simons, Li and Associates using a known-discharge sediment-routing procedure called HEC2SR. The model determines scour in reaches of a river system based on available sediment supply, local hydraulic conditions, and sediment-transport capacity. Hydraulic conditions for the river are determined using the U.S. Army Corps of Engineers HEC-2 computer program. The procedure was designed to take advantage of the bridge hydraulic modeling routines in HEC-2. Output from the modeling procedure includes detailed hydraulic and sediment-transport data as well as cross-sectional information. Application of the model to a complex site is shown. The analysis procedure provides important information pertinent to the design of river-training measures used in conjunction with bridge crossings. (Author's abstract)
W85-06119

ROLE OF CALIBRATION IN APPLICATION OF HEC-6,
D. M. Gee.
Transportation Research Record, Vol. 950, No. 2, p 252-259, 1984. 7 Fig, 1 Tab, 14 Ref.

Descriptors: *Calibration, *Scour, *Channel morphology, *Model studies, *Bridge design, Design criteria, Mathematical models, Movable boundary models, Streambeds, Sediment transport.

Calibration, the process of adjusting model parameters so that model results conform with observed prototype behavior, is an essential ingredient of any modeling effort, be it physical or mathematical. Successful application of movable boundary models often require substantial effort to reproduce field observations. The key components of the calibration and verification process for movable boundary numerical modeling (i.e., HEC-6) applications are: comprehending the historical behavior of the stream system; developing representative geometric, sediment, and hydrologic data; and performing and verifying the calibration. The calibration is performed by (a) selecting calibration measures of changes in bed profile, changes in cross-sectional geometry, changes in volumes of sediment, rating curve shifts, and other characteristics that suit study level and objectives; (b) selecting the calibration time period; (c) identifying acceptable model performance; and (d) adjusting parameters. Calibration strategies vary widely depending on the type and availability of field data and study scope and objective. HEC-6 may be used in bridge design for prediction of long-term trends in streambed profile behavior; analysis can be made of the impacts of various scenarios regarding upstream and downstream actions. (Collier-IVI)
W85-06120

CONTEMPORARY LAKE TRANSPORT PROCESSES DETERMINED FROM SEDIMENTARY RECORDS OF COPPER MINING ACTIVITY,
Freshwater Biological Association, Ambleside (England).
W. Davison, J. Hilton, J. P. Lishman, and W. Pennington.
Enviromental Science and Technology, Vol. 19, No. 4, p 356-360, April, 1985. 5 Fig, 1 Tab, 19 Ref.

Descriptors: *Sediment transport, *Fate of pollutants, *Mining, *Coniston Water, *England, Copper, Iron, Magnesium, Calcium, Particulates, Lake sediments, Chalcopyrite, Organic carbon, Water depth.

In the recent past (ca. 1850) copper was mined in the catchment of Coniston Water in the English Lake District. Chemical analysis of sediment cores shows a clear record of this activity. Although the mining effluent entered the lake at one place, elevated concentrations of Cu, Fe, Mg, and Ca were observed at all five sites investigated, showing the domination of random transport processes in distributing sediment material. Other effects such as progressive downstream settling, which play a minor but significant role in the local copper loading, are identified. A constant excess Cu:S ratio of 2:1 indicated that Cu is present in the sediments as chalcopyrite and that it was transported from the mine workings in particulate form. Mn accumulation is mediated by redox processes, and so the final concentration in the sediment depends on the depth of the overlying water and the availability of organic carbon. (Author's abstract)
W85-06150

EVALUATION OF THE EROSION INDEX FOR THE PRAIRIES,
Saskatchewan Univ., Saskatoon. Dept. of Soil Science.
R. G. Kachanoski, and E. de Jong.
Canadian Journal of Soil Science, Vol 65, No. 1, p 225-228, February, 1985. 1 Fig, 1 Tab, 12 Ref.

Descriptors: *Soil erosion, *Universal soil loss equation, *Prairies, Erosion, Mathematical equations, Rainfall, Storms, Saskatchewan.

The universal soil loss equation (USLE) has had limited use in the prairies due partly to the lack of information about the various equation parameters. Ateshian's equation, used to calculate the USLE rainfall erosion index (R) for Canada, appears to considerably overestimate the actual R value for Saskatchewan (calculated from 12 yr of tipping bucket rainfall data). An alternative equation derived using a generalized distribution curve for prairie rainstorms predicted an R value of 350 for Saskatoon which was close to the 12-yr average (R = 340) for Saskatoon. More R values need to be calculated from existing climatological data to determine which (if any) estimation equation is satisfactory. In addition, a method or index for estimating erosion potential due to snowmelt needs to be developed. (Moore-IVI)
W85-06153

SEDIMENTATION PROCESSES IN AN IMPOUNDMENT, UNION LAKE, NEW JERSEY,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Geological Sciences.
T. H. Calcagno, and G. M. Ashley.
Environmental Geology and Water Science, Vol. 6, No. 4, p 237-246, 1984. 8 Fig, 3 Tab, 30 Ref.

Descriptors: *Sedimentation, *Reservoirs, *Union Lake, *New Jersey, Maurice River, Organic matter, Cesium radioisotopes, Sand, Dy, Diatoms, Silt, Clay, Wind, Water circulation.

A small (3.75 sq km) impoundment, Union Lake, on the Maurice River in southern New Jersey contains fine-grained sediment and organic material being transported through the surface water system. Sedimentation is slow and rates calculated from Cs-137-dated cores indicate a decrease through time from 2.6 mm/yr to 0.57 mm/yr. Sediment from shallow areas (< 3 m) consists of winnowed preimpoundment fluvial sand, whereas sediment from deeper area (> 3 m) is dy composed of diatoms, organic matter, and silt- and clay-sized mineral grains. Sediment distribution is controlled by water moving from the river entrance southward toward the outlet and by wind-generated water motion from shallow areas fringing the shore toward deeper portions of the impoundment. (Author's abstract)
W85-06162

2K. Chemical Processes

PRESENCE OF TIN AND TUNGSTEN IN THERMAL WATERS CONNECTED WITH GRANITES OF SOME SELECTED REGIONS IN EUROPE,
Gdansk Technical Univ. (Poland).
For primary bibliographic entry see Field 2F.
W85-05857

ISOTACHOPHORETIC DETERMINATION OF ANIONIC AND CATIONIC SPECIES IN WELL AND SURFACE WATERS,
Karlova Univ., Prague (Czechoslovakia). Dept. of Physical Chemistry.
For primary bibliographic entry see Field 5A.
W85-05910

THEORY OF SOLUTE TRANSPORT IN SOILS FROM THE METHOD OF CHARACTERISTICS,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 2G.
W85-05937

PARTICLE SIZE DISTRIBUTION, CHEMICAL COMPOSITION AND CALCULATION OF STANDARD MINERALOGICAL COMPOSITION OF SUSPENDED SEDIMENT TRANSPORTED BY A STREAM IN OKINAWA ISLAND,
Okinawa Inst. of Physicachemical Research, Okinawa City.
For primary bibliographic entry see Field 2J.
W85-05996

DISTRIBUTION OF MINOR METALLIC ELEMENTS IN RIVER WATER OF GREEN TUFF REGION, YAMAGATA PREF.,
Yamagata Univ. (Japan). Dept. of Chemistry.
T. Iriye.
Japanese Journal of Limnology, Vol. 45, No. 4, p 260-268, October, 1984. 4 Fig, 4 Tab, 10 Ref.

Descriptors: *Heavy metals, *Chemical composition, *Rivers, *Yamagata Prefecture, *Japan, Granite, Tuff, Cadmium, Chromium, Copper, Manganese, Nickel, Lead, Zinc, Trace elements.

The concentrations of 7 minor heavy metallic elements (Cd, Cr, Cu, Mn, Ni, Pb and Zn) were determined by the atomic absorption spectrometry method in 116 river water samples, of which 13 samples were collected from the granitic region and others from the green tuff region in Yamagata Prefecture, Japan. High concentration areas of the metallic elements were found in the east, southeast and central part of the survey area. In consideration of their flow rate, the mean concentrations of the metallic elements in river water were obtained. The mean values of 0.35 ppb of Cd, 3.74 ppb of Cr, 6.92 ppb of Cu, 15.39 ppb of Mn, 3.32 ppb of Ni, 5.45 ppb of Pb and 17.26 ppb of Zn were found in the green tuff region. The mean values of these elements in the granitic region was lower than that of the green tuff region except for Cr. Since it can be considered that these river water sampling sites are not affected by human activities, these values, except for lead, represent the minor metal concentration in close to its natural state. (Author's abstract)
W85-05997

EFFECTS OF BENTHIC MACROINVERTEBRATES ON THE EXCHANGE OF SOLUTES BETWEEN SEDIMENTS AND FRESHWATER,
Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences.
G. Matisoff, J. B. Fisher, and S. Matis.
Hydrobiologia, Vol. 122, No. 1, p 19-33, March, 1985. 10 Fig, 1 Tab, 49 Ref. Ohio Sea Grant project R/ER-5, EPA contract R8057160, NOAA grant NA80RAD0036, NSF grant OCE8005103.

Descriptors: *Benthic fauna, *Invertebrates, *Sediments, *Solutes, Oligochaetes, Midges, Clams, Diagenesis, Ammonium, Bicarbonates, Silica, Iron, Phosphates, Nitrates, Diffusion, Solute transport, Sediment-water interfaces.

Infaunal macrobenthos (tubificid oligochaetes, chironomid larvae, and unionid bivalves) were studied in laboratory microcosms to determine their effects on freshwater sediment diagenesis and the exchange of solutes between sediments and water. Tubificids enhanced the flux of ammonium, bicarbonate, and silica from sediments. After the onset of anoxia, they decreased the flux of iron and phosphate. Chironomids increased the flux of nitrate, bicarbonate, and silica, but did not affect the flux of phosphate. Pore water concentrations were low within the irrigated burrowed zone for chemical species normally high in reduced sediments. Concentration gradients were less steep in the actively irrigated burrow zone, but radial diffusion to and from burrows, increased rates of organic de-

composition, and enhanced diatom frustule dissolution rates result in enhanced mass transport from sediments. Data from an experiment with unionid clams demonstrated the presence of radial diffusion gradients. These clams enhanced the chloride and nitrate flux from sediments, decreased the bicarbonate flux, but did not affect the flux of either phosphate or silicate. Although the clams did not actively irrigate their burrows, their effect on sediments was similar to that of chironomids. Comparison of direct and indirect flux estimates showed that both types of estimates could be highly variable. In general, indirect flux estimates were higher than direct flux estimates. (Author's abstract)
W85-06005

NITROGEN MIGRATION IN ZHUJIANG RIVER (IN CHINESE),
Academia Sinica, Guangzhou (China). South China Sea Inst. of Oceanology.
For primary bibliographic entry see Field 5B.
W85-06010

IDENTIFICATION OF WATER SOURCES USING NORMALIZED CHEMICAL ION BALANCES: A LABORATORY TEST,
Agricultural Research Service, Tucson, AZ. Southwest Watershed Research Center.
D. A. Woolhiser, W. E. Emmerich, and E. D. Shirley.
Journal of Hydrology, Vol. 76, No. 3/4, p 205-231, February, 1985. 2 Fig, 7 Tab, 18 Ref, 1 Append.

Descriptors: *Normalized chemical ion balance, *Water sources, Surface waters, Groundwater, Natural waters, Ion balance, Chemical composition, Streams.

A normalized chemical ion balance (NCIB) technique, that has been proposed to identify multiple surface and groundwater inflows to a reach of a stream, is tested using two sets of mixtures prepared in the laboratory. The first set consisted of 64 mixtures of from 2-8 natural waters selected from 10 source waters. A second set of 25 mixtures was prepared using 5 source waters. Each of the source waters and each mixture was analyzed for at least 8 ions. Proportions of source water in each sample were estimated using a quadratic programming solution to minimize the sum of squared error terms of normalized chemical ion-balance equations. Because PO4(3-) was present in very low concentrations, and was subject to significant error, it was found that better estimates could be obtained by omitting it from the analyses. For the first mixture set, the probability of failure to detect a source when it was present in the mixture was 0.23, and the probability of identifying a source when it was not present was 0.29. For the second set of mixtures, the probabilities were 0.0 and 0.33, respectively. Identification was improved by dividing each normalized ion-balance equation by the error variance for that ion. (Author's abstract)
W85-06045

DENITRIFICATION IN A MAJOR LIMESTONE AQUIFER,
Toronto Univ. (Ontario). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W85-06048

INTERFLOW OF WATER AND TRACER CHEMICAL ON SLOPING FIELD PLOTS WITH EXPOSED SEEPAGE FACES,
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 5B.
W85-06050

ACID PRECIPITATION: NATURAL VERSUS ANTHROPOGENIC COMPONENTS,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. N. Galloway, G. E. Likens, and M. E. Hawley.
Science, Vol. 226, No. 4676, p 829-831, November, 1984. 2 Fig, 15 Ref.

Descriptors: *Acid precipitation, *Monitoring, *Sulfates, Nitrates, Hydrogen ion, Acidity, Urban areas, Rural areas, Chemistry of precipitation, Water pollution sources.

Using data from the Global Precipitation Chemistry Project networks, three specific questions are addressed: what are the concentrations of sulfate, nitrate and hydorgen ions in precipitation in remote areas; how does the composition of precipitation in remote areas compare to that in eastern North America, and which ion is the most ecologically significant in assessing the magnitude of the change in precipitation composition due to anthropogenic activities. Concentrations of hydrogen, nitrate and sulfate ions were elevated in eastern North America precipitation as compared to remote areas. The sulfate ion appears to be a better indicator of change than the other two. It is misleading to use the hydrogen ion for comparison because remote areas have a different mixture of acids and bases than eastern North America and H(+) is therefore not a conservative tracer. In the case of nitrate ions, because of rapid uptake by biota in terrestrial and aquatic ecosystems, it does not promote longterm acidification of aquatic ecosystems as much as sulfate ions. Because the sulfate ion is conservative, does not vary significantly among the remote sites, and is the primary control on the acidification of aquatic ecosystems, it is suggested as the best indicator of changes in precipitation composition between remote areas and eastern North America. (Baker-IVI)
W85-06060

DETERMINATION OF SEVEN TRACE ELEMENTS IN NATURAL WATERS BY NEUTRON ACTIVATION ANALYSIS AFTER PRECONCENTRATION WITH 1-(2-PYRIDYLAZO)-2-NAPHTHOL,
Dalhousie Univ., Halifax (Nova Scotia). Trace Analysis Research Centre.
H. Bem, and D. E. Ryan.
Analytica Chimica Acta, Vol. 166, p 189-197, December, 1984. 3 Fig, 3 Tab, 21 Ref.

Descriptors: *Trace elements, *Neutron activiation analysis, *Preconcentration, Natural waters, Cadmium, Cobalt, Chromium, Copper, Manganese, Uranium, Zinc, Radioisotopes, Water analysis.

A procedure is described for the preconcentration of Cd(II), Co(II), Cr(III), Cu(II), Mn(II), U(VI) and Zn(II) from 800 ml of water and sea-water samples by coprecipitation with 1-(2-pyridylazo)-2-naphthol (PAN) prior to neutron activation. Chromium is reduced to Cr(III) by hydroxylammonium chloride at pH 4 before the preconcentration step. Coprecipitation of 30 mg of PAN was most effective at pH 9 with final recoveries of 76-91% for six elements and 50% for uranium. The scheme is based on double irradiation of the same samples. Short (10 min) irradiation followed by gamma-spectrometry counting for 10 min gives data for Cd (Cd-111m), Co, Cu, Mn and U(U-239). A second 16-h irradiation permits determination of zinc and uranium (Np-239) after a waiting time of 6 h, cadmium (Cd-115) after 24 h and chromium after a waiting period of 2 weeks followed by counting for 30 min. Detection limits are 0.04 ng/g for Co, 0.8 ng/g for Cd, 0.3 ng/g for Cu, 0.2 ng/g for Cr, 0.006 ng/g for Mn, 0.006 ng/g for U and 0.3 ng/g for Zn. A further decrease of the detection limit for chromium to 0.05 ng/g can be achieved by separation of interfering nuclides and scintillation counting of Cr-51 with a NaI(Tl) well-type detector. (Author's abstract)
W85-06165

2L. Estuaries

EFFECTS OF THE BLACK RIVER (CAPE, SOUTH AFRICA) ON THE DISTRIBUTION AND SURVIVAL OF MARINE PSAMMOFAUNA,
Texas A and M Univ., College Station. Dept. of Veterinary Anatomy.
A. D. Scarfe, A. B. Thum, and C. L. Wilke.
Marine Pollution Bulletin, Vol. 16, No. 2, p 69-75, February, 1985. 8 Fig, 2 Tab, 32 Ref.

Descriptors: *Black River, *South Africa, *Water pollution effects, *Coastal waters, Species composition, Marine environment, Dredging, Benthos.

The physicochemistry of the Black River and adjacent marine beach - in terms of tidal, daily and seasonal fluctuations of temperature and salinity - presents a highly stressed environment exacerbated by canalization of the river mouth. Riverine pollution further stresses this environment, producing low densities and diversities of marine infauna adjacent to the river. No fauna were found in the river mouth where typical estuarine conditions exist only during high tide. Tolerance of the dominant marine species, Cerebratulus fuscus, to temperature, salinity and river water combinations showed that mortality was more rapid after exposure to river water dilutions than after exposure to distilled water dilutions. Computer-generated models suggested that this species should survive conditions closer to the river than were observed. This confirmed additional stress due to pollution carried in the river from urban and industrial drainage. Lower river water temperatures during winter appear to ameliorate pollution stress, enhancing survivability of the infauna. (Author's abstract)
W85-05861

CATASTROPHIC ANOXIA IN THE CHESAPEAKE BAY IN 1984,
Johns Hopkins Univ., Baltimore, MD. McCollum-Pratt Inst.
H. H. Seliger, J. A. Boggs, and W. H. Biggley.
Science, Vol. 228, p 70-73, April, 1985. 2 Fig, 18 Ref. NSF grant OCE-8208745.

Descriptors: *Chesapeake Bay, *Anoxic conditions, Streamflow, Climate, Dissolved oxygen, Pycnocline, Stratification, Hydrogen sulfide, Estuarine environment, Temperature effects, Shellfish.

In 1984, four climatic sequences combined to produce what may be a major anoxic castastrophe in the northern Chesapeake Bay, sufficient to severely threaten the major benthic species. These sequences are (i) the highest late-winter streamflow on record from the Susquehanna River watershed; (ii) streamflows from the Susquehanna River for the consecutive months of June, July, and August that are higher by 2 standard deviations than the respective monthly mean values measured over the last 34 years; (iii) a stationary high in August off Atlantic Coast; and (iv) and absence of strong storm events in summer. An empirical equation is proposed for the prediction of the monthly trend of dissolved oxygen decrease in terms of a temperature-dependent subpycnoclinal respiration and a modified estuarine Richardson number. As of 23 August 1984, the summer pycnocline of the northern bay had eroded upward from its historically recorded depth below 10 meters to an abnormally shallow 5 meters, with higher stratification than in earlier years. Dissolved oxygen concentrations directly below the pycnocline decreased to zero during June, 2 months earlier than for previous wet years. At present, oxygen-deficient waters containing significant concentrations of hydrogen sulfide have penetrated into Eastern Bay and the Choptank and Potomac rivers. Because most remaining shellfish-spawning and seed-bed areas in these tributaries are located at depths between 4 and 8 meters, the continued absence of major destratifying events will prolong the present anoxic trend and may result in high benthic mortalities. (Author's abstract)
W85-06159

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

REVERSE OSMOSIS MEMBRANE FOULING AND PRETREATMENT CONSIDERATIONS,
S. F. Rak.
Industrial Water Engineering, Vol. 21, No. 4, p 12-

15, August, 1984. 3 Fig, 3 Ref.

Descriptors: *Reverse osmosis, *Desalination, *Membrane processes, *Water treatment, Scaling, Suspended solids, Membrane fouling, Suspended solids, Colloids, Metal oxides, Oil, Grease.

The type of solutes and foreign substances that can foul reverse osmosis membranes are reviewed. General guidelines for avoiding the problems associated with foulants are discussed. Unless pointed out to the contrary, the information applies to cellulose acetate and composite polyamide membranes. In general, hollow fiber modules are more inclined to foul than spiral modules. Types of fouling most commonly encountered are: scale formation, biological slime formation, suspended solids fouling, colloidal fouling, metal oxide deposition, and oil and grease deposition. Generally speaking, if it is determined that the solubility limit of a sparingly soluble salt will be exceeded, one or more of the following measures must be taken: reduce the product water recovery ratio to avoid exceeding solubility limits, soften the water by ion exchange to remove the polyvalent metal ions, feed acid such as hydrochloric and sulfuric to reduce the pH and the bicarbonate/carbonate level, and add scale inhibitors such as sodium hexametaphosphate for sulfates. Experience has proven that many years of service can be obtained from reverse osmosis membrane modules if sufficient attention is paid to the quality of the feed water. The likelihood of failure is almost 100% if one chooses to ignore reverse osmosis pretreatment. (Baker-IVI)
W85-05993

3B. Water Yield Improvement

SOLAR EARTH-WATER DISTILLATION FOR WET SAND,
Arkansas Univ., Fayetteville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W85-06073

3C. Use Of Water Of Impaired Quality

EFFECT OF SODIUM AND BICARBONATE IRRIGATION WATERS ON SODIUM ACCUMULATION AND ON MAIZE AND WHEAT YIELDS IN NORTHERN INDIA,
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils.
For primary bibliographic entry see Field 2I.
W85-05921

SALT TOLERANCE OF CORN IN THE SACRAMENTO-SAN JOAQUIN DELTA OF CALIFORNIA,
Agricultural Research Service, Riverside, CA. Salinity Lab.
G. J. Hoffman, E. V. Maas, T. L. Prichard, and J. L. Meyer.
Irrigation Science, Vol. 4, No. 1, p 31-44, April, 1983. 6 Fig, 5 Tab, 6 Ref.

Descriptors: *Salt tolerance, *Corn, *Sacramento-San Joaquin Delta, *California, Irrigation water, Saline water, Water management, Water stress, Water quality, Soil properties, Crop yield, Electrical conductivity.

A field trial was conducted in the Sacramento-San Joaquin Delta of California to determine the salt tolerance of corn in organic soil. Threshold values were obtained which were similar to those published for mineral soils. Neither the climate nor the organic soil in the Delta significantly altered the salt tolerance threshold. The salt tolerance slopes obtained for this field trial were more than twice as steep as published values. Water management prevented any water stress in sprinkled treatments and very little water stress, if any in the subirrigated treatments. Good agreement was found among measurements of the electrical conductivity of soil water from suction cups, four-electrode salinity probes, and soil samples. Because of high water holding capacity of the soil and high leaching, the electrical conductivity of the soil water was never more than several dS/m higher than the electrical conductivity of the applied water. Plant yields were high on nonsaline treatments but were reduced when soil salinity exceeded 3.7 dS/m. Excess salinity reduced yields by reducing kernel mass and, to a lesser extent, ear density. Root density measurements indicated a root zone depth of 90 cm. The method of irrigation did not affect the salt tolerance of corn significantly. (Baker-IVI)
W85-05925

EFFECT OF HIGH SODIUM IRRIGATION WATER ON SOIL SALINITY AND YIELD OF MATURE GRAPEFRUIT ORCHARD,
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Environmental Physiology.
H. Bielorai, J. Shalhevet, and Y. Levy.
Irrigation Science, Vol. 4, No. 4, p 255-266, December, 1983. 2 Fig, 6 Tab, 23 Ref.

Descriptors: *Grapefruit trees, *Irrigation water, *Saline water, *Saline soils, *Crop yield, Chlorides, Sodium, Exchangeable sodium percentage, Infiltration.

Citrus is considered to be specifically sensitive to chloride and sodium, yet little data exist to show the effect of these ions on yield. An experiment was started in 1978 to study to effect of sodic irrigation water on yield. The treatments were SAR (sodium adsorption ratio) of the irrigation water of 2.8-(L), 5.5-(M), and 10.3-(H) (mol/cu m) to the 1/2 (SAR = Na(+)/square root Ca(++) + Mg(++)/2). The experiment follows a study on the same plots using irrigation water of variable chloride concentration and a uniform SAR of 4.2 (mol/cu m) to the 1/2. The high SAR, high Cl water resulted in a yield reduction of 9% from the control treatment. This reduction was similar to the reduction observed when only Cl was a variable. Total water uptake was reduced as salt concentration in the soil increased. The average water uptake for the four irrigation seasons 1978 to 1981 was 1025 mm, 953 mm and 823 mm for the L, M and H treatments, respectively. Soil ESP (exchangeable sodium percentage) was increased as a result of sodium accumulation in the soil profile in the M and H treatments, while Cl and EC remained relatively constant with time during the experiment. After four years of irrigation the infiltration capacity values were 0.26, 0.17 and 0.16 cm/h for the L, M and H treatments, respectively. Fruit quality was not affected by the treatments. No specific toxicity symptoms were observed when the Na concentration in the soil saturation extract was 16 mol/cu m and the ESP was 8.0. The results lead to the conclusion that within the range used in this experiment the high ESP did not specifically affect yield and that yield response was due to the total salt concentration in the soil. (Author's abstract)
W85-05935

3D. Conservation In Domestic and Municipal Use

CALCULATING EFFECTIVENESS OF WATER CONSERVATION MEASURES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 6F.
W85-06021

IMPACT OF CONSERVATION ON RATES AND OPERATING COSTS,
Dauphin Consolidated Water Supply Co., Harrisburg, PA.
For primary bibliographic entry see Field 6C.
W85-06031

3F. Conservation In Agriculture

EFFECT OF LAND SURFACE UNIFORMITY ON SOME ECONOMIC PARAMETERS OF IRRIGATION IN SODIC SOILS UNDER RECLAMATION,
Central Soil Salinity Research Inst., Karnal (India).
N. K. Tyagi.
Irrigation Science, Vol. 5, No. 3, p 151-160, October, 1984. 5 Fig, 4 Tab, 15 Ref.

Descriptors: *Irrigation, *Economic aspects, *Sodic soils, Soil management, Irrigation practices, Infiltration, Crop yields, Land reclamation, India, Water application.

One requirement of a good irrigation system is uniform water application throughout the field, but for all irrigation sytems, water application is nonuniform to some degree. Increasing the average application depth until all portions of the field receive sufficient water to maximize crop yield can have detrimental effects on sodic soils which have poor internal drainage and low oxygen diffusion rates. The effect of leveling uniformity measured in terms of mean deviation from the desired plane and designated as leveling index on some irrigation quality parameter such as water application and distribution was investigated in sodic soils irrigated by graded borders. For exploiting full yield potential on sodic soils, a high frequency application and low magnitude irrigation practice is recommended. The water application depth in surface irrigation ensuring full irrigation, is not a management controlled variable, but is greatly influenced by the quality of leveling. Higher application depths which are associated with poor leveling, do not permit frequent applications. For the soils at Karnal, which are representative of the alkali soils in the Indo-Gangetic plains in India, both irrigation efficiencies and crop production can be maximized if the system application depth are within 4-5 cm. For ensuring the desired system application depths to maximize net income, the leveling quality has to be such that the average deviation from the desired level is within 3 cm. (Baker-IVI)
W85-05917

WATER USE EFFICIENCY OF NARROW ROW COTTON,
Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
T. A. Howell, K. R. Davis, R. L. McCormick, H. Yamada, and V. T. Walhood.
Irrigation Science, Vol. 5, No. 3, p 195-214, October, 1984. 10 Fig, 7 Tab, 50 Ref.

Descriptors: *Irrigation, *Crop yield, *Cotton, *Water use efficiency, *San Joaquin Valley, *California, Evapotranspiration, Water use, Soil water, Leaf temperature, Transpiration, Water stress, Row spacing.

A field experiment was conducted on the west side of the San Joaquin Valley in California to determine water use, crop growth yield and water use efficiency of Acala (SJ-2) cotton grown in 0.5 m spaced rows on a Panoche clay loam soil. Evapotranspiration was determined by water balance techniques using neutron soil moisture measurements. The dry matter production of cotton grown in narrow rows was directly related to both measured evapotranspiration and estimated transpiration determined from a soil water balance model. This biological production can be maximized by irrigation management resulting in minimum crop water stress. The water use efficiency across widely varying cropwater stress levels was largely explained by a model using leaf temperature inferred from canopy temperature measurements taken by infrared thermometry. The lint production of cotton grown in narrow rows was related to evapotranspiration. The lint production was directly related to estimated transpiration. The lint production of cotton in narrow rows can be maximized by irrigation management or minimize direct soil water evaporation while minimizing water deficit effects on crop transpiration. The imposition of crop water deficits through irrigation management of narrow row cotton reduced the crop growth rates; the effects of the water deficits only marginally affected both net assimilation and relative growth rates. The important practical significance is related to partitioning of the dry matter production. Although the dry matter partitioning of the

cotton in this experiment was remarkably similar for considerable water deficit differences, the results indicate that moderate water stress prior to flowering can result in larger boll partitioning and an increased harvest index. (Baker-IVI)
W85-05918

MICROCLIMATE AND CROP RESPONSES TO CENTER PIVOT SPRINKLER AND TO SURFACE IRRIGATION,
Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
J. L. Steiner, E. T. Kanemasu, and D. Hasza.
Irrigation Science, Vol. 4, No. 3, p 201-214, August, 1983. 6 Fig, 6 Tab, 19 Ref.

Descriptors: *Sprinkler irrigation, *Surface irrigation, *Microclimate, Diurnal variation, Seasonal variation, Evapotranspiration, Water stress, Crop yields.

Analyses of seasonal and diurnal microclimatic responses to sprinkler and surface irrigation indicate that sprinkler irrigation can provide cooling during stress periods. Part of the advantage of sprinkler irrigation may be the increased frequency of irrigation compared to surface irrigation methods. When evaporative demand is high, as is commonly found in the southern High Plains, frequently applied water will be held at a high soil water potential near the surface and will be readily extractable by the plant. During nonstress periods of crop growth, microclimatic and plant responses to sprinkler irrigation are much less than are seen during stress periods of the crop growth. (Baker-IVI)
W85-05922

MODIFICATION OF IRRIGATION REQUIREMENT OF WHEAT THROUGH MULCHING AND FOLIAR APPLICATION OF TRANSPIRATION SUPPRESSANTS,
Indian Agricultural Research Inst., New Delhi. Div. of Agronomy.
R. De, D. V. S. Bhujanga Rao, Y. Y. Rao, L. G. Giri Rao, and M. Ikramullah.
Irrigation Science, Vol. 4, No. 3, p 215-223, August, 1983. 4 Fig, 4 Tab, 8 Ref.

Descriptors: *Wheat, *Irrigation requirements, *Mulching, *Antitranspirants, Water loss, Evapotranspiration, Soil properties, Kaolin, Alachlor, Soil texture, Crop yield, Water stress.

Field experiments on wheat for 2 years showed a beneficial effect of organic mulch (rice straw), reflective transpiration suppressant (kaolin) or metabolic antitranspirant (alachlor) by decreasing the evapotranspiration losses of soil water, increasing grain yield and thus water use efficiency. The effect of mulching and/or antitranspirant application on available soil water status was hardly discernible at flowering or at maturity stage on the loamy-sand soil where only 2 irrigations had been given. This was not so on the clay-loam soil where even under relative stress situation the soil moisture conservation effect through evapotranspiration control was noticeable up to the grain filling or grain maturity stage. While mulching was more effective than antitranspirant on a clay loam soil, this was not the case for the loamy-sand soil. The reasons for these observed differences on a heavy and coarse textured soil are not currently understood. (Baker-IVI)
W85-05923

NONUNIFORM SPRINKLER IRRIGATION AND CROP YIELD,
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
J. Stern, and E. Bresler.
Irrigation Science, Vol. 4, No. 1, p 17-29, April, 1983. 6 Fig, 5 Tab, 14 Ref.

Descriptors: *Sprinkler irrigation, *Crop yield, Irrigation practices, Plant growth, Corn, Soil water, Soil hydraulic properties, Water application, Soil texture.

The influence of nonuniform water application by sprinkler on the variability of soil water content and corn yield was studied on two experimental plots differing in their texture and hydraulic characteristics. The yield and the water content were treated as random variables depending indirectly on the spatial coordinates and directly on the volume of water applied, on soil hydraulic properties, and on other factors. The trend of soil water content and crop yield appears to be caused by the trend in water application. Soil properties of both experimental plots may be considered as homogeneous so that the responses of soil water content and in turn of crop yield resulted mainly from the nonuniformity of water application. Redistribution of soil water after irrigation caused crop yield to be more uniform in the plot where the soil hydraulic properties led to more significant water flow. Dry matter yield response to net water application, as measured in collection cans, was fitted to the Mitscherlich's model - the law of diminishing returns. Using normal distribution to characterize the probability density function of water application and the Christiansen coefficient to characterize the uniformity criteria in the fitted Mitscherlich's model enabled relative crop yield to be expressed as a function of Christiansen coefficient and the total amount of irrigation water. (Baker-IVI)
W85-05924

SALINATION OF ORGANIC SOILS IN THE SACRAMENTO-SAN JOAQUIN DELTA OF CALIFORNIA,
California Univ., Stockton. Cooperative Extension Service.
T. L. Prichard, G. J. Hoffman, and J. L. Meyer.
Irrigation Science, Vol. 4, No. 1, p 71-80, April, 1983. 8 Fig, 1 Tab, 8 Ref.

Descriptors: *Irrigation water, *Saline water, *Saline soils, *Organic soils, *Sacramento-San Joaquin Delta, *California, Soil physical properties, Salt tolerance, Water management, Soil water.

The Delta is an important agricultural area containing organic soils that are threatened by salinity. To aid in water allocation and management decisions, the maximum salinity level in irrigation water that preserves agricultural production was estimated from data gathered in a field trial to establish the salt tolerance of corn. All of the physical properties measured indicated that the soil at the field trial was typical of organic soils in the Delta and elsewhere. Organic matter content increased from 45% near the soil surface to nearly 60% in the subsoil. Bulk density decreased with depth from 0.7 Mg/cu m to about 0.2 Mg/cu m. Volumetric water content at saturation increased from 0.64 cu m/cu m at the 30-cm depth to 0.90 cu m/cu m below 1 m. Differences in sample preparation techniques were found to influence measurements of soil salinity in subsoil samples. Measurements of electrical conductivity on samples brought to saturation without either grinding or drying agreed best with more direct measures of soil salinity. Rainfall during the winter had a significant impact on soil salinity. Above average rainfall combined with water table control rainfall effectively leached the upper soil profile. The ratio between the salinity of the irrigation water and the resultant soil salinity was a function of the salinity of the irrigation water and not constant for the organic soils of the Delta. (Baker-IVI)
W85-05927

DESIGN OF DRIP IRRIGATION LATERAL LENGTH ON UNIFORM SLOPES,
Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.
I. P. Wu, C. A. Saruwatari, and H. M. Gitlin.
Irrigation Science, Vol. 4, No. 2, p 117-135, June, 1983. 7 Fig, 2 Tab, 11 Ref.

Descriptors: *Design criteria, *Irrigation design, *Lateral length, *Drip irrigation, Slopes, Mathematical equations, Maximum pressure difference.

A design procedure is presented which will determine the design of drip irrigation lateral length directly for a given design criterion. When a lateral line is designed for a uniform slope situation, a dimensionless design parameter can be used to determine the pressure profile and maximum pressure difference along the line. Graphical solutions and mathematical equations were derived for determining the maximum pressure difference. A design length can be determined directly by using the developed design charts. The developed design procedure can also be used for upslope situations. The design lateral line length obtained from an ideal design may not be accepted if its maximum pressure difference is larger than the design criterion. An ideal design can still be made by adjusting the length lateral line size, or the specific discharge. When an ideal solution cannot be accepted, a new design length can be determined based on an allowable maximum pressure difference. The developed method offers a direct determination of lateral line length for a given design criterion. The design procedure can be used for both downslope and upslope but it is not applicable for zero slope. For a zero slope situation, design can be made by simply using a friction drop equation such as the commonly used Williams and Hazen formula. (Baker-IVI)
W85-05929

ESTIMATING WATER APPLICATION EFFICIENCY IN IRRIGATION CHECKS,
Central Soil Salinity Research Inst., Karnal (India).
S. K. Gupta, R. N. Pandey, and R. K. Batta.
Irrigation Science, Vol. 4, No. 2, p 137-146, June, 1983. 3 Fig, 3 Tab, 5 Ref.

Descriptors: *Check irrigation, *Estimating, *Water application efficiency, Percolation, Water loss, Water management, Mathematical equations.

Irrigation in checks consists in dividing the area to be irrigated into square or rectangular plots with the minimum possible slope along the plot length. The plot size is governed by the water supply and infiltration characteristics of the soil. Equations to predict the percolation loss and water application efficiency in irrigation checks have been derived assuming the advance of the water front to be of a specified form. Simple equations based on water distribution geometry in irrigation checks have been suggested for situations where the advance function is not known. The observed field data and the comparison with exact solution indicate that elliptic and parabolic geometry of intake profiles give a better prediction accuracy compared to the straight line intake profile previously used. (Baker-IVI)
W85-05930

EFFECT OF WATER STRESS AT THREE GROWTH STAGES ON THE YIELD AND WATER-USE EFFICIENCY OF DWARF WHEAT,
Haryana Agricultural Univ., Hissar (India). Dept. of Agronomy.
T. Singh, and D. S. Malik.
Irrigation Science, Vol. 4, No. 4, p 239-245. December, 1983. 4 Tab, 15 Ref.

Descriptors: *Water stress, *Wheat, *Crop yield, *Water use efficiency, Plant growth, Plant water potential, Leaves, Soil water, Irrigation scheduling.

The responses of dwarf wheat (Triticum aestivum L.) to three levels of water stress at three growth stages, planting to jointing, jointing to flowering and flowering to maturity was studied under field conditions over two seasons at Hissar, India. At each of these stages, plants were subjected to three levels of water stress viz. -0.5, -1.0 and -1.5 MPa mid-day leaf water potential; during the remaining growth period, the plants were irrigated at 50% available soil moisture (ASM). Thus mild, moderate and severe stress treatments were compared with a no stress control (irrigation at 50% depletion of available soil water). A maximum grain yield of 5.20 tons/ha was recorded with no water stress treatment. All levels of water stress except -0.5 MPa during flowering to maturity reduced the grain yield significantly compared to the no stress treatment. The greatest effect of water stress on grain yield was observed during the planting to jointing stage. At this stage the highest reduction in grain yield (33.5%) was observed with -1.5 MPa

plant water stress. Similar plant water stress during jointing to flowering and flowering to maturity reduced the grain yield by 26.0 and 22.6% respectively. During flowering to maturity, the effect of water stress on straw yield was not well marked. During planting to jointing and jointing to flowering stages, mild, moderate and severe water stress decreased the number of ear-bearing culms, whereas number of grains per ear reduced with all water stress levels at all the stages except -0.5 MPa water stress during flowering to maturity. Maximum reduction in 1000-grain weight was observed with all stress levels imposed during flowering to maturity stage. Water-use efficiency was highest with no water stress (13.9 kg/ha mm) and lowest with -1.5 MPa plant water stress (11.2 kg/ha mm) imposed during planting to jointing stage. Results indicate that the wheat crop should be irrigated at 50% depletion of available soil water (ASW). (Author's abstract)
W85-05933

IRRIGATION SYSTEM UNIFORMITY FUNCTION RELATING THE EFFECTIVE UNIFORMITY OF WATER APPLICATION TO THE SCALE OF INFLUENCE OF THE PLANT ROOT ZONES,
Louvain Univ. (Belgium). Dept. of Agricultural Engineering.
O. G. Cogels.
Irrigation Science, Vol. 4, No. 4, p 289-299, December, 1983. 9 Fig, 7 Ref.

Descriptors: *Irrigation systems, *Uniformity function, *Scale of influence, *Root zone, Simulation, Mathematical studies, Sampling, Water application, Irrigation.

A uniformity function which takes into account the horizontal scale of influence of individual plant root-zones is derived from both measured and simulated sprinkler water application depths. A new mathematical tool for the analysis of the spatial variability of measurements, the 'scalogram', is introduced for the computation of the uniformity function. The effect of the density of the sampling pattern and of the local randomness on the shape of the uniformity function is studied with simulated water application depths. It is shown that the function is practically independent of the sampling density if equal or higher than the recommended one and that local randomness, i.e. measurement errors, only affects the shape of the function for small scales of influence of plant root-zones. (Author's abstract)
W85-05938

PERFORMANCE OF LOW PRESSURE CENTER PIVOT SYSTEMS,
Washington State Univ., Pullman. Dept. of Agricultural Engineering.
L. G. James, and S. K. Blair.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1753-1757 and 1762, November-December, 1984. 6 Fig, 8 Ref.

Descriptors: *Center pivot irrigation, *Irrigation practices, *Sprinkler irrigation, Computer models, Model studies, Water use efficiency, Terrain, Energy, Water pressure.

Many sprinklers that operate at pressures as low as 140 kPa are being used with center pivot irrigation systems. These sprinklers normally wet a smaller area and have higher average application rates than do the high pressure impact sprinklers which have been traditionally used with center pivot systems. A computer simulation model was used to compare the effect of sprinkler spacing and terrain on the theoretical performance of six center pivots. Equations for computing sprinkler discharge from nozzle diameter and operating pressure and for computing wetted radius were added to an existing model, as were shape functions for representing the application patterns of low pressure impact sprinklers and fixed head spray sprinklers. Systems with impact sprinklers and low pressure fixed head spray sprinklers had the highest uniformities for constant spacings of 12 and 1.5 m, respectively. Energy use was highest on upward sloping terrains. Terrain had little, if any, effect on the uniformity and adequacy of application or peak application rates for a particular center pivot system. Spray systems used 30% less energy and had higher mean and peak application rates than a system with impact sprinklers. (Collier-IVI)
W85-06083

PREDICTING SEDIMENT DEPOSITION PATTERNS IN PIPES WITH DIMINISHING FLOW,
Washington State Univ., Pullman. Dept. of Agricultural Engineering.
L. G. James, and B. A. King.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1758-1762, November-December, 1984. 5 Fig, 1 Tab, 8 Ref.

Descriptors: *Sedimentation, *Pipelines, *Low flow, *Irrigation practices, Conveyance structures, Sprinkler irrigation, Trickle irrigation, Model studies.

Deposition of particulate material often occurs in submain lines and laterals in sprinkler and trickle irrigation systems because of the stepwise decrease in velocity from the upstream to downstream end of the pipe due to lateral and sprinkler (or emitter) discharge. The design of irrigation systems which use water high in suspended sediments which cannot be economically removed by filtration should consider the transport and depostion of particulate materials. A model was developed to predict the spatial and temporal accumulation of sediment in pipes with diminishing flow, such as submains and laterals. Sediment accumulation patterns predicted with the model were compared to data from field experiments involving 12.7 and 14.7 mm diameter trickle laterals with vortex-type emitters and sediment inflow concentrations of 65 and 260 mg/L. The model was found to satisfactorily predict the spatial and temporal accumulation of sediment for these combinations of lateral diameters and sediment inflow concentrations. Inflow rate, particle size and density, pipe lengths, bulk density of the deposited sediment, and number of emitters were constant. Satisfactory agreement was found between measured and model predicted sediment deposition patterns. (Collier-IVI)
W85-06084

WATER MANAGEMENT FOR GUAYULE RUBBER PRODUCTION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
D. A. Bucks, F. S. Nakayama, and O. F. French.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 7, p 1763-1770, November-December, 1984. 7 Fig, 3 Tab, 14 Ref.

Descriptors: *Guayule, *Water management, *Arizona, Evapotranspiration, Canopy temperatures, Rubber, Irrigation, Crop production, Water stress.

Guayule used water for the first two years in response to soil water availability and environmental demands at Mesa, Arizona. Evapotranspiration determinations for three cultivars from May 1981 through December 1982, averaged 3000, 2410, 2040, 1720, 1470, and 1520 mm (118, 95, 80, 68, 58, and 60 in.) in decreasing order of water applications for six irrigation treatments. Plant canopy temperatures as measured by an infrared thermometer showed a progressive increase in stress behavior as irrigation water applications decreased. Plant temperatures as high as 8 C (14 F) above air temperatures were recorded during the summer months on the dry treatment without plant death; whereas, plant temperatures on the wet treatment were seldom more than 1 C (1.8 F) above air temperature. Rubber yields were significantly higher on the wetter than drier treatments because of the greater biomass on the wetter treatments. Although guayule can withstand long periods of drought, optimum production will not be achieved in a short period without using an extremely wet irrigation schedule. (Author's abstract)
W85-06085

HYDRAULIC RAM USE FOR SPRINKLE IRRIGATION,
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
K. Kitani, and L. S. Willardson.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1788-1791, November-December, 1984. 4 Fig, 6 Ref.

Descriptors: *Hydraulic rams, *Sprinkler irrigation, *Irrigation, Pumping plants, Water hammer, Energy.

Hydraulic rams work on the principle that a large volume of water with a low head can be used to pump a smaller volume of water to a higher head using the water hammer effect. Hydraulic rams have not been widely used for irrigation, and, particularly, have not been used for application to sprinkler irrigation. Direct hydraulic ram use for sprinkle irrigation was studied on a 24.3 ha (60 acre) farm near Cornville, Arizona. Results indicated that hydraulic rams could be effectively used for direct sprinkle irrigation. Operation costs are low and hydraulic rams can be installed where outside energy is difficult to obtain. The least head ratio, the ratio of delivery head to supply head, is an important design factor for continuous hydraulic ram operation for sprinkle irrigation. Pressure fluctuations inherent in a hydraulic ram pumping system are not expected to seriously affect water distribution patterns. If a suitable installation site is available, use of hydraulic rams may be the most economical pumping system for sprinkler irrigation. (Collier-IVI)
W85-06088

NUMERICAL ANALYSIS OF IRRIGATION TREATMENTS OF BARLEY WITH RESPECT TO DRAINAGE LOSSES AND CROP RESPONSE,
Punjab Agricultural Univ., Ludhiana (India). Dept. of Agronomy.
R. K. Mahey, J. Feyen, and G. Wyseure.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1805-1810 and 1816, November-December, 1984. 5 Fig, 5 Tab, 20 Ref.

Descriptors: *Numerical analysis, *Irrigation practices, *Barley, *Drainage, *Crop yield, Soil water balance, Model studies, Transpiration, Irrigation efficiency.

A numerical analysis of a barley field experiment conducted during 1974-1975 and 1975-1976 with different irrigation treatments was done to determine the drainage losses and crop response with respect to the irrigation management. To evaluate the obtained experimental results, a numerical soil water balance model, SWATRE, was used to estimate the actual transpiration. There is a close agreement between the measured and simulated moisture depths, after calibration of the SWATRE model, during both of the growing seasons of the crop. The calculated actual transpiration was used as a major input in the growth model, CROPR, in order to verify crop response in the irrigation treatments applied. The CROPR model, under the given agricultural practices, was able to simulate grain yield. Both SWATRE and CROPR models are useful tools in the re-orientation, optimization and reduction of field research related to the effect of irrigation scheduling on crop yield and field irrigation efficiency. (Author's abstract)
W85-06091

BORDER IRRIGATION MODEL SELECTION,
Concepcion Univ. (Chile). Dept. of Agricultural Engineering.
E. A. Holzapfel, M. A. Marino, and J. Chavez-Morales.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1811-1816, November-December, 1984. 5 Fig, 3 Tab, 23 Ref.

Descriptors: *Border irrigation, *Model studies, *Irrigation practices, Soil types, Kinematic wave theory, Mathematical analysis, Volume balance models, Zero inertia models.

The capability of zero-inertia, kinematic-wave, and volume-balance models to predict advance and recession phases in free-end border irrigation were compared to field data for different values of border width and discharge in a loamy and sandy loam soil. All models give very good predictions of the advance. An excellent estimation of the recession times was obtained with the zero-inertia model. The kinematic-wave model predicted the advance of the water front well, but its estimates of recession times were not as good. The volume-balance model estimated the recession times well by using an algebraic method. The final volume of infiltrated water and its longitudinal distribution depend on the opportunity time. If the opportunity time is large, errors in the advance or recession curves will have a small effect in the computed infiltration depth, because infiltration rates are small at large times. Reasonable estimation of the advance of the water front and recession times are important in determining the quality of the irrigation. The time ratio (ratio of time irrigation cutoff to time when the water front reaches the end of a run) plays an important role in design and management of border irrigation systems. (Author's abstract)
W85-06092

DESIGNING FURROW-IRRIGATION SYSTEMS FOR IMPROVED SEASONAL PERFORMANCE,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
T. K. Gates, and W. Clyma.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 3, p 1817-1824, November-December, 1984. 2 Fig, 6 Tab, 30 Ref. AID contract AID/DSAN-C-0058.

Descriptors: *Irrigation practices, *Furrow irrigation, *Irrigation design, Seasonal variation, Crop yield, Design criteria, Soil infiltration, Colorado.

Furrow irrigation system design using a quasi-rational procedure was evaluated to determine its effect on the seasonal performance of typical farmer-managed system. The infiltration characteristics of the soil and the required depths of application at the times of each of five different irrigations through a season were determined for a farmer-managed field in northern Colorado. A design process that does not account for seasonal variations in field conditions results in poor seasonal performance for situations similar to the case study. The inadequacy of the design is primarily due to the failure to account for the higher intake rate and shallower root zone depth occurring at the beginning of the season. Thus, the traditional design approach based upon conditions during the period of peak consumptive use is unacceptable from an operational stand point because it results in unacceptable system performance. A design strategy that involved an early season design to account for the distinct hydraulic and crop constraints characteristics of the system during the early part of the irrigation season was evaluated. Design of system capability and hydraulic structures should allow for management and operational flexibility to cope with seasonal variations in field conditions. (Baker-IVI)
W85-06093

DROP SIZE DISTRIBUTIONS FOR A LOW PRESSURE SPRAY TYPE AGRICULTURAL SPRINKLER,
South Dakota State Univ., Brookings. Dept. of Plant Science.
R. A. Kohl, and D. W. DeBoer.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1836-1841, November-December, 1984. 12 Fig, 12 Ref.

Descriptors: *Irrigation practices, *Sprinklers, *Spray irrigation, Fluid drops, Center pivot irrigation, Design criteria.

Drop size distributions from agricultural irrigation sprinklers are of interest because: (1) wind velocities can distort application patterns and smaller drops are more sensitive to wind; and (2) the influence of drop size on drop kinetic energy and its subsequent impact on the soil surface can modify the infiltration characteristics of a soil. Droplet distributions were derived for a 360 deg spray nozzle with nozzle sizes ranging from 4.8 to 9.5 mm and pressure ranging from 50 to 200 kPa. Smooth and serrated spray plates were also used. Smaller nozzles used on the inner half to two-thirds of the center pivot, are less likely to cause crusting because their distributions tended toward smaller drop size classes and their application rates are lower; little or no runoff should occur in this area. Even if wind drift would be significant, the drift from these smaller nozzles would not likely pass beyond the wetted area of the sprinkler system and be a loss to the field. The larger nozzles are used at the outer end of the system where application rates are high, where soil crusting and runoff can be a problem, and where drift has an opportunity to fall beyond the irrigated field. The geometry of the spray plate surface is the dominant parameter that influences drop size distribution when compared to nozzle size and water pressure. The smooth plate produced the smallest droplets and the coarse grooved plate produced the largest. Additional data on the effects of impingement plate design on drop size distribution is needed. (Collier-IVI)
W85-06096

WATER USE EFFICIENCY OF WHEAT IN A MEDITERRANEAN-TYPE ENVIRONMENT. I THE RELATION BETWEEN YIELD, WATER USE AND CLIMATE,
South Australia Dept. of Agriculture, Adelaide.
R. J. French, and J. E. Schultz.
Australian Journal of Agricultural Research, Vol. 35, No. 6, p 743-764, 1984. 7 Fig, 8 Tab, 60 Ref.

Descriptors: *Water use efficiency, *Wheat, *Crop yield, *Climate, Evaporation, South Australia, Australia, Grains, Sowing, Timing, Soil water.

The relations between wheat yield and water use were determined from field measurements in South Australia. Highest production of dry matter was 37 kg/ha per mm of water use and of grain was 12.7 kg/ha per mm. More than 70% of the total water use occurred by anthesis. Time of sowing and soil water content at sowing had a big influence on yield. The loss of water by direct evaporation was estimated to be 110 mm, equal to about one-third of the water use. The maximum efficiency of water transpired was 55 kg/ha/mm for dry matter and 20 kg/ha/mm for grain. The efficiencies of most of the crops were below this level. Yield (Y), water use (W) and evaporation (Ep) could be fitted to the de Wit formula $Y = mW/Ep$, but the m factor varied with the proportion of water use that was lost by direct evaporation. (Author's abstract)
W85-06099

TRIADIMEFON REDUCES TRANSPIRATION AND INCREASE YIELD IN WATER STRESSED PLANTS,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
For primary bibliographic entry see Field 2I.
W85-06104

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

WATER MANAGEMENT FOR SMALL URBANIZING WATERSHED,
Iowa State Univ., Ames. Dept. of Civil Engineering.
R. L. Rossmiller.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 123-136, April, 1985. 6 Fig, 7 Tab, 13 Ref.

Descriptors: *Water management, *Urban watersheds, *Ames, *Iowa, Artificial recharge, Quarries, Water quality, Water supply, Recreation, Flood control, Drought.

In 1976 and 1977, the city of Ames, Iowa had to ration water due to a locally severe drought. Some relief was obtained by artifically recharging the depleted aquifer by pumping water from a nearby sand and gravel quarry. Since the drought, city engineering and Iowa State University personnel have conducted studies to make the quarry a permanent part of the city's sources of water supply. These studies have included both water quantity and water quality studies. The results of these studies with emphasis given to the water quantity studies and results are explored. This account of how one city turned the solution of a water supply problem into an opportunity to incorporate water quality, flood control, and recreation considerations into a more complete over-all solution can serve as a model for other cities to use as they strive to find solutions to their own unique water-related problems. (Author's abstract)
W85-06026

IRRIGATION SYSTEM STUDY IN INTERNATIONAL BASIN,
Indian Inst. of Tech., New Delhi. Dept. of Applied Mechanics.
For primary bibliographic entry see Field 6A.
W85-06027

OPTIMAL OPERATION OF CALIFORNIA AQUEDUCT,
California State Dept. of Water Resources, Sacramento.
M. H. Sabet, J. Q. Coe, H. M. Ramirez, and D. T. Ford.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 222-237, April, 1985. 5 Fig, 3 Tab, 14 Ref, 1 Append.

Descriptors: *California Aqueduct, *Optimization, *Energy, *Operating costs, Pumping, Peak demand, Linear programming, Water demand, Hydroelectric power, California State Water Project, Model studies, Computer models.

The goals and objectives of operation of the California State Water Project (SWP) changed significantly on March 31, 1983, when long-term, low-cost contractual agreements for energy purchase for the Project terminated. Now energy required for pumping must be purchased at a substantially increased cost. However, energy generated in the Project can be sold with maximum revenues at times of peak electrical demand. To determine the most efficient operation schedules for the SWP, a coordinated set of models was developed for execution in 'real time.' This set of models includes network flow programming models, a number of other simulation models, and a large-scale linear programming (LP) model designed to determine optimal flows throughout the California aqueduct system, given the energy demands for pumping, energy generation capabilities and water demands. This LP model may be executed with a weekly or daily time step. Solution of the LP problem is accomplished with the nonproprietary XMP package, using the dual-simplex capability to accelerate solution. (Author's abstract)
W85-06033

EVALUATING SUBSURFACE DRAINAGE BENEFIT ESTIMATION FROM SHORT-TERM CROSS-SECTION DATA,
Guelph Univ. (Ontario). School of Agricultural Economics and Extension Education.
W. van Vuuren, and H. Jorjani.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1719-1723, November-December, 1984. 1 Fig, 4 Tab, 16 Ref.

Descriptors: *Subsurface drainage, *Crop yield, Drainage, Evaluation, Economic aspects, Corn, Precipitation, Cost analysis.

An estimation procedure for the change in corn yield caused by subsurface drainage was examined. Long term series of annual yield data provide the

ideal data set, but are virtually nonexistent. The conditions under which short-term data provide a good proxy for the average annual yield increase over the lifetime of the drainage system are examined. Data in this case was obtained from observations covering four years and a large number of farms in a region with variable precipitation. A condition that must be met in order to make these short term cross section data reliable proxies for long term data is that the precipitation regime over the short term over a region with variable precipitation is the same as the precipitation regime over the long term at any site in the region. For the four years under consideration, average precipitation was considerably higher during two specific periods than over the long term. In general, caution is needed in using the short term cross section data for an investment analysis of subsurface drainage. Calculation of the break even yield provides some subjective indication about economic viability. If the average yield on which the analysis is based far exceeds the break even yield, the investment is probably economically sound, although the judgement is subjective. (Baker-IVI)
W85-06077

UTILITY APPROACH TO COMPREHENSIVE STORMWATER MANAGEMENT,
Fort Collins Dept. of Public Works, CO. Engineering Services.
M. Engemoen, and R. E. Krempel.
Public Works, Vol. 116, No. 4,p 68-71, 92, April, 1985. 2 Fig, 1 Tab.

Descriptors: *Storm runoff, *Water management, *Fort Collins, *Colorado, Utilities, Urban runoff, Financing.

In 1980 Fort Collins established a stormwater utility by bringing drainage activities together in a single program. These activities include routine operations, maintenance and administration of the existing drainage system, and the engineering and development of a comprehensive capital improvements program. To fund operations, maintenance, and administration, the City began charging property owners a monthly utilities fee, based on the property's area and land use characteristics, which amounted to about $1 per month for single family residences. Almost a year later additional fees were instituted for storm drainage capital improvements in three of nine drainage basins. The framework of the Fort Collins stormwater management program was established in the storm drainage ordinance of 1976. In this ordinance two important drainage principles were delineated: that all real property within a drainage basin will be benefited by the installation of an adequate storm drainage system; and that the cost of installing an adequate drainage system should thus be assessed against the real property in a basin. The storm drainage ordinance of 1976 emphasized the importance of individual drainage basins. The city was divided into nine major basins, and over a three year period, developed storm drainage master plans for each one. Each master plan evaluated the basin hydrology under existing conditions to identify existing drainage problems. Each plan identified the system of improvements needed to provide safe and effective storm drainage within the basin. The financing plan used by the city is described. (Baker-IVI)
W85-06125

SOIL SALINITY STATUS AND ITS RELATION TO SOME OF THE SOIL AND LAND PROPERTIES OF THREE IRRIGATION DISTRICTS IN SOUTHERN ALBERTA,
Department of Agriculture, Lethbridge (Alberta). Research Station.
C. Chang, G. C. Kozub, and D. C. Mackay.
Canadian Journal of Soil Science, Vol. 65, No. 1, p 187-193, February, 1985. 1 Fig, 3 Tab, 14 Ref.

Descriptors: *Saline soils, *Irrigation effects, *Alberta, Soil texture, Electrical conductivity, Water table, Clay, Slope, Soil properties.

A detailed soil salinity survey was carried out in three of the 13 irrigation districts in southern Alberta. About 30 quarter-sections in each district were randomly selected for soil sampling. The location, distance from water supply ditches, slope of the land, and depth to till and water table at each site were recorded. Soil texture and electrical conductivity of extracts of soil samples were determined in the laboratory. The extent of the area with a soil salinity level of 4 dS/m or more is 5% of the total surveyed land in the Western Block of the St. Mary River Irrigation District (WSMRID), 6% in the Lethbridge Northern Irrigation District (LNID) and 9% in the Taber Irrigation District (TID). These values are not as high as others have previously estimated. The salinity level of the soil at each site was found to vary with its location and distance from water supply ditches in the WSMRID and LNID, clay content in the 0- to 120-cm depth in the WSMRID and TID, and water table level in the TID. (Author's abstract)
W85-06151

4B. Groundwater Management

WATER MANAGEMENT FOR SMALL URBANIZING WATERSHED,
Iowa State Univ., Ames. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W85-06026

CONJUNCTIVE UTILIZATION OF SURFACE WATER AND GROUNDWATER TO ARREST THE WATER-LEVEL DECLINE IN AN ALLUVIAL AQUIFER,
National Geophysical Research Inst., Hyderabad (India).
C. P. Gupta, S. Ahmed, and V. V. S. Gurunadha Rao.
Journal of Hydrology, Vol. 76, No. 3/4, p 351-361, February, 1985. 10 Fig, 3 Tab, 4 Ref.

Descriptors: *Groundwater, *Alluvial aquifers, *Conjunctive use, *Daha region, *India, Canals, Irrigation, Water demands, Water supply development, Water resources development, Groundwater recharge, Groundwater recession.

The groundwater regime in the Daha area of the Krishni and Hindon interstream region in Uttar Pradesh, India has been very extensively exploited, causing an appreciable decline of groundwater levels. The area is underlain by unconsolidated fluviatile deposits, which are thick and porous. The aquifer zone extends up to 100 m below ground surface and has a saturated thickness ranging between 22 and 50 m. The entire system was regarded as interconnected in view of the observed interfingering of sand and clay lenses. For model construction purposes the area of about 300 sq km was divided into 79 node points with a uniform grid spacing of 2 km. The groundwater flow equation was transformed into a finite-difference form using the backward difference approximation. The interpolated transmissivity pattern based on field estimates was the starting point for model construction. During the dynamic phase of modeling it was found that the rivers, which were initially effluent in nature, have gradually been becoming influent as a result of declining groundwater levels. The trend of water level decline due to over exploitation of groundwater in this area could possibly be offset considerably by conjunctive utilization of surface and groundwater, particularly during the surplus period. A possible approach in this regard is to construct a network of unlined canals in the area. The variation in the aquifer response as a result of the introduction of the proposed canal network was computed. The effect of the canal on the aquifer system will be two-fold: pumpage from the aquifer will be reduced as water for irrigation will also be drawn from the canals; and there will be an additional recharge to the aquifer due to seepage in the unlined canals. (Baker-IVI)
W85-06053

ARKANSAS GROUNDWATER MANAGEMENT VIA TARGET LEVELS,
Arkansas Water Resources Research Center, Fayetteville.
R. C. Peralta, and A. W. Peralta.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1696-1703, November/December, 1984. 6 Fig, 13 Ref.

Descriptors: *Groundwater management, *Arkansas, *Pumping, Riparian rights, Groundwater level, Resources management, Boussinesq equation.

An approach to groundwater management by maintaining 'target' groundwater elevations was developed. A finite difference form of the Boussinesq equation was proposed as a means of determining the groundwater withdrawals that will maintain those levels in the long term. This spatially distributed pumping can represent a sustained yielding pumping strategy. A sample pumping strategy was presented for the Arkansas Grand Pairie. Such a strategy is applicable under a variety of legal systems. It represents an especially attractive alternative for riparian rights states (like Arkansas) where effective groundwater management without radical changes in the basic water rights system is desired. (Author's abstract)
W85-06074

4C. Effects On Water Of Man's Non-Water Activities

HIGHWAY IMPACTS ON WETLANDS: ASSESSMENT, MITIGATION, AND ENHANCEMENT MEASURES,
M. H. Thrasher.
Transportation Research Record, Vol. 948, p 17-20, 1984. 7 Ref.

Descriptors: *Wetlands, *Environmental effects, *Highways, *Construction, Water pollution sources, Soil properties, Land management, Conservation, Legal aspects.

General wetland types and their basic functions and values are identified, and highway construction impacts, impact assessment, and mitigation and enhancement procedures are discussed. Special emphasis is given to the reconstruction of wetlands affected by highway construction. Wetlands are characterized by the periodic or permanent presence of water in a sufficient amount to make it the dominant factor in determining the nature of soil development and the types of plant communities living in it or on its surface. Most wetlands are important to fish, shellfish, waterfowl, and other wildlife, although specific values differ. Highway construction in wetlands is regulated by federal and state laws. The unavoidable adverse impact on wetlands by a proposed highway construction activity may be permitted provided that such construction is judged to be in the public interest and an acceptable plan to mitigate wetland losses is implemented. A central component of the mitigation plan is compensating or offsetting unavoidable weland losses. The objectives are basically of two kinds: the mitigation of adverse impacts and the enhancement of wetlands. (Baker-IVI)
W85-06065

HYDROGEOCHEMICAL ASPECTS OF SURFACE MINE RECLAMATION IN THE NORTHERN GREAT PLAINS,
North Dakota Mining and Mineral Resources Research Inst., Grand Forks.
G. H. Groenewold, and R. D. Koob.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1711-1718, November-December, 1984. 3 Fig, 2 Tab, 20 Ref. Bureau of Mines contract J0275020, EPA grants R-805939 and R-805459.

Descriptors: *Coal mining, *Strip mines, *North Dakota, *Great Plains, *Geochemistry, *Land reclamation, Hydrogeology, Hydrologic models, Sodium, Sulfate, Mineralization, Groundwater pollution.

Surface coal mining activities in the Northern Great Plains have generated considerable concern with respect to potential impacts on postmining

plant growth success and groundwater quality. Studies of several coal-mining sites in western North Dakota resulted in the development of a hydrogeochemical model which accounts for the observed chemical characteristics of subsurface water in undisturbed settings. Recent refinements in the hydrogeochemical model focused on the sulfur cycle and determination of the applicability of the model to postmining landscapes. Field activities included detailed groundwater instrumentation of undisturbed and spoils areas at two geologically distinctive mine sites in western North Dakota. Refinement of the model included analyses of the texture, bulk mineralogy, clay mineralogy, sufide abundance, and sulfur concentration in overburden core samples. Lab experiments were designed to determine the source and mechanisms of sulfate salt production from overburden samples. The model is equally applicable to undisturbed and spoils landscapes and the major species of concern in this region are sodium and sulfate. The major source of sulfate is sulfides in the overburden and the solubility of sulfate in groundwater in these settings is largely controlled by the sodium/calcium ratio. The negative hydrogeochemical impacts resulting from surface mining in the Northern Great Plains will include increased mineralization of groundwater and sodic and salt effects on plants. The degree of these impacts will be dependent on site-specific hydrogeological, geochemical, and mineralogical variables. A consideration of these non-soils aspects of surface-mined lands thus is essential to proper surface mine reclamation design in this region. (Baker-IVI)
W85-06076

4D. Watershed Protection

URBAN SEDIMENT AND STORMWATER CONTROL: THE MARYLAND EXPERIENCE,
Maryland Water Resources Administration, Annapolis.
R. E. Benner.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 72-75, January-February, 1985.

Descriptors: *Maryland, *Water pollution control, *Urban runoff, *Storm water, Nonpoint pollution sources, Runoff, Sediments, Erosion control, Construction, Legislation.

Five decades ago Marylanders realized that soil and water resources must be conserved and they set out to develop rural and urban control programs for sediment and for stormwater runoff. For three decades, state efforts focused solely on sediment problems in rural areas. Then in the fourth decade urban development resulted in the ruling that silt discharged into the waters of the state from land clearing or development operations was legally subject to regulatory control by the state agency. In 1977 Maryland put into effect an interim watershed management policy directing that all state-financed or state-constructed projects be reviewed for stormwater management. About 1982, officials decided that the most rational, effective approach to stormwater management was maintaining as nearly as possible natural runoff flow characteristics. As the stormwater management effort gained momentum, a State Stormwater Management Law was passed in 1982. This law requires each county and municipality to adopt a stormwater management ordinance based on the state criteria. As the sediment control program emerged in the 1970s the state's administrative costs totalled $72,000 per year and remained at that level for the entire decade. But the sediment control program has grown, especially with emphasis on cleaning up the Chesapeake Bay. The state's current commitment to the sediment and stormwater management program including the $1.7 million for local programs, approaches the $3 million mark. (Baker-IVI)
W85-05951

SEDIMENT DEPOSITS IN DRAINAGE DITCHES: A CROPLAND EXTERNALITY,
Ohio State Univ., Columbus.
For primary bibliographic entry see Field 2J.
W85-05965

SUBSIDY AND TAX EFFECTS OF CONTROLLING STREAM SEDIMENTATION IN SOUTH CAROLINA,
Mississippi State Univ., Mississippi State. School of Forestry.
R. D. Seale, J. W. Hubbard, and E. H. Kaiser.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 144-148, January-February, 1985. 1 Fig, 8 Tab, 6 Ref.

Descriptors: *Subsidies, *Taxes, *Sediment control, *Streams, *South Carolina, Conservation tillage, Crop production, Soil conservation, Economic aspects, Costs, Sedimentation.

A model consisting of a farm enterprise budget generator, a hydrologic model, and a matrix generator was used to address several questions in a specific watershed: the subsidy required to induce farmers to adopt conservation tillage crop production systems; the tax on conventional crop production systems required to render those systems less profitable than systems that conserve more soil or create less stream pollution; how adoption of conservation tillage practices would offset stream sedimentation; the effects restricting stream sedimentation from farming operation would have on income; the potential tradeoffs between stream pollution and farm income. Subsidies, taxes, and the imposition of sediment restrictions all could reduce stream pollution, but there would be large differences among these approaches in costs, stream pollution, soil loss, and farm incomes. Because of the difficulty of designing and enforcing a scheme to restrict stream sedimentation to predetermined levels, subsides and tax potentials have greater potential. At all levels of subsidies and taxes from $5/acre to $50/acre, the tax program resulted in a 10 to 11% greater reduction in sediments than the subsidy program. Farmers suffered more under the taxing scheme than under the subsidy program. (Moore-IVI)
W85-05966

RUNOFF, SOIL, AND NUTRIENT LOSSES FROM RANGELAND AND DRY-FARMED CROPLAND IN THE SOUTHERN HIGH PLAINS,
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
For primary bibliographic entry see Field 5B.
W85-05970

BEST MANAGEMENT PRACTICES FOR CONTROLLING NONPOINT-SOURCE POLLUTION ON FORESTED WATERSHEDS,
Pennsylvania State Univ., University Park.
For primary bibliographic entry see Field 5G.
W85-05971

PLANT NUTRIENT LOSSES BY SOIL EROSION AND MASS MOVEMENT AFTER WILDFIRE,
Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab.
For primary bibliographic entry see Field 2J.
W85-05972

SOIL EROSION STUDY OF EXPOSED HIGHWAY CONSTRUCTION SLOPES AND ROADWAYS,
B. A. Anderson, and D. B. Simons.
Transportation Research Record, Vol. 948, p 40-47, 1984. 9 Fig, 1 Tab, 9 Ref.

Descriptors: *Erosion control, *Highways, *Slopes, *Construction, Design criteria, Design criteria, Model studies, Soil erosion,.

The sediment generated during and after highway construction is often excessive unless proper erosion control measures are taken. The quantities of sediment produced from construction slopes and roadways are determined, and a methodology to assist in the determination of these quantities is presented. The data collection program was conducted on 10 representative soils in the study area and included testing of cut slopes, fill slopes, road surfaces, and undisturbed sites above the roadway. The data were analyzed and used as input to a simple mathematical model. Additional input parameters were estimated and the model was calibrated. After the calibration, a procedural guide and an interactive program were developed. These can both be used to assist the planner in determining the sediment produced from different roadway design alternatives. Both the procedural guide and the interactive method are limited regionally to the soils tested and the sites evaluated during this study. The interactive program and procedural guide are limited to assessing the erosion from relatively simple road geometries. Even so, with an expanded field data collection program, improved methodologies similar to those presented in this paper could be produced for any selected geographic region. (Baker-IVI)
W85-06069

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

POLLUTION MONITORING USING THE NEMATODE/COPEPOD RATIO, A PRACTICAL APPLICATION,
Napier Coll., Edinburgh (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W85-05860

HYDROCARBONS AND HALOGENATED HYDROCARBONS IN COASTAL WATERS OF THE ENGLISH CHANNEL AND THE NORTH SEA,
IFREMER, Brest (France).
M. Marchand, and J. C. Caprais.
Marine Pollution Bulletin, Vol. 16, No. 2, p 78-81, 1985. 1 Fig, 6 Tab, 5 Ref.

Descriptors: *Coastal waters, *Water pollution control, *Pollutant identification, *Hydrocarbons, *Polychlorinated biphenyls, *Lindane, *English Channel, *North Sea, Sampling, Water analysis, Chemical analysis, Industrial wastes.

The quality of coastal marine waters is monitored in France within the framework of Reseau National d'Observation, a program financed by the Ministry of the Environment. In October of 1983 the first campaign to measure hydrocarbons and halogenated hydrocarbons in the English Channel and North Sea was undertaken. A total of 50 sampling stations were selected. Two major sources of total hydrocarbons and PCBs and lindane were found in the Seine estuary and the Calais-Dunkirk industrial and urban zone in the North Sea. Significant correlations were found between all the parameters measured, hydrological (salinity, turbidity, suspended matter), and organic pollutant (hydrocarbons, PCBs, lindane) parameters in the coastal strip influenced by the Seine. A coefficient of decreasing concentrations of total hydrocarbons and PCBs approximately the same as that of suspended matter was found between the two limit conditions, the estuary and the typically marine region. On the other hand, the coefficient for lindane is quite different, of the order of 20, and nearer to that of salinity. Both the observations show that for total hydrocarbons and PCBs extractable compounds which are easily adsorbed into particulate matter, the behavior and process of dispersion at the mouth of the estuary is essentially linked to sedimentary mechanisms. Conversely, the distribution process of lindane, a compound which is more soluble, is primarily linked to water mass movements. (Baker-IVI)
W85-05862

USE OF THE AURELIA METAMORPHOSIS TEST SYSTEM TO DETECT SUBTLE EFFECTS OF SELECTED HYDROCARBONS AND PETROLEUM OIL,
Eastern Virginia Medical School, Norfolk, VA. Dept. of Pathology.

For primary bibliographic entry see Field 5C.
W85-05890

DEVELOPMENT OF A RAPID, SENSITIVE AND QUANTITATIVE TEST FOR THE ASSESSMENT OF THE EFFECTS OF XENOBIOTICS ON REPRODUCTION IN FISH,
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
T. T. Chen, and R. A. Sonstegard.
Marine Environmental Research, Vol. 14, No. 1-4, p 429-430, 1984.

Descriptors: *Water pollution effects, *Xenobiotics, *Pollutant identification, *Vitellogenin, *Fish, Trout, Water quality control, Monitoring, Immunoelectrophoresis.

A rocket immunoelectrophoresis procedure was developed as a rapid quantification of the levels of vitellogenin in serum samples. The method measures quantitatively the presence of vitellogenin in serum at a concentration as low as 0.5 micro-g/10 micro-l. Upon treatment of juvenile rainbow trout with estradiol at 20 micro-g/100 g body weight, the production of vitellogenin was readily induced within 6 days at 15 C. Fish of 50 g body weight were fed a diet contaminated with 3, 30, or 300 ppm of PCBs, or with 0.5, 5, or 50 ppm Mirex, or with a mixture of PCBs (30 ppm) and Mirex (5 ppm) for 6 months. Results indicate the production of vitellogenin induced by estradiol was greatly reduced by PCB, Mirex and a mixture of the two. A molecular hybridization assay was developed to increase the accuracy and sensitivity of assaying the production of vitellogenin in fish. Results indicate that MFO inducers reduce synthesis of vitellogenin mRNA. The production of vitellogenin induced by estradiol can thus be used as a sensitive test for evaluating the potential effects of xenobiotics on fish reproduction. (Baker-IVI)
W85-05895

ALTERATIONS IN TISSUE WATER BALANCE AND ADENYLATES OF BLUEGILL (LEPOMIS MACROCHIRUS) EXPOSED TO COPPER,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W85-05898

HISTOPATHOLOGY OF MERCENARIA MERCENARIA AS AN INDICATOR OF POLLUTANT STRESS,
Delaware Univ., Newark. School of Life and Health Sciences.
For primary bibliographic entry see Field 5C.
W85-05899

ISOTACHOPHORETIC DETERMINATION OF ANIONIC AND CATIONIC SPECIES IN WELL AND SURFACE WATERS,
Karlova Univ., Prague (Czechoslovakia). Dept. of Physical Chemistry.
J. Vacik, and I. Muselasova.
Journal of Chromatography, Vol. 320, No. 1, p 199-203, February, 22, 1985. 2 Fig, 4 Tab, 12 Ref.

Descriptors: *Water analysis, *Pollutant identification, *Isotachophoresis, Well waters, Natural waters, Chlorides, Nitrates, Sulfates, Potassium, Sodium, Calcium, Magnesium, Chemical composition.

Electrolyte systems and the conditions for the isotachophoretic determination of anions (chloride, nitrate and sulfate) and cations (potassium, sodium, calcium, and magnesium) in well and surface waters are described. The results of isotachophoretic determinations on practical samples are compared with those obtained by classical methods. A typical isotachopherogram of a mixture of the anions is shown. The results for five different water samples are also displayed and compared with results obtained by classical metods. Chloride and sulfate were determined titrimetrically and nitrate photometrically, after reaction with sodium salicylate, potassium and sodium were determined by flame photometry and magnesium and calcium ions were titrated cheloatometrically. An isotachopherogram of a mixture of the cations is depicted and the results are tabulated. The electrolyte system used does not allow the separation of ammonium from potassium ions or the separation of barium from sodium ions. (Baker-IVI)
W85-05910

ISOTACHOPHORESIS OF CATIONIC HERBICIDES IN WATERS AND SOILS,
Palacky Univ., Olomouc (Czechoslovakia). Dept. of Analytical and Organic Chemistry.
Z. Stransky.
Journal of Chromatography, Vol. 320, No. 1, p 219-231, February, 1985. 7 Fig, 7 Tab, 34 Ref.

Descriptors: *Pollutant identification, *Isotachophoresis, *Herbicides, Soil analysis, Water analysis, Agricultural chemicals, Organic compounds, Path of pollutants.

A method for the determination of quaternary cationic herbicides (diquat and paraquat) and triazine herbicides in water and soil extracts by capillary isotachophoresis is proposed. More basic triazines (atratone, or prometryne) can be determined directly using enforced isotachophoresis. Very weak triazine bases (atrazine, or simazine, for example) have to be derivatized by nucleophilic substitution of chlorine by electron-donor or quaternary ammonium groups. Recoveries from soils are 70-80% of quaternary and 90-95% of triazine herbicdes. The limit of determination with both the types of herbicides is about 10 micro-g/kg of sample. Capillary isotachophoresis can be used as a rapid method for monitoring the composition of commercial formulations. The formation of ion associates could also be used for the concentration of quaternary herbicides from aqueous solution. Ion associates of bivalent cations are not completely extractable into organic solvents. The distribution ratios are too low for satisfactory isolation. The stable ion associates formed between dodecyl sulfate and the semi-reduced cation radical can be extracted almost quantitatively by one-step extraction. This fact simplifies the determination of herbicides in waters where extraction can replace the concentration of an ion exchanger and thus it increases the sensitivity of both isotachophoretic and spectrophotometric determinations at the 10 micro-g/liter level. The isotachophoretic determination is more reproducible. The spectrophotometric determination has the disadvantage of easy re-oxidation of the cation radical which occurs during the measurement and decreases the precision of the method. (Baker-IVI)
W85-05911

COLIFORMS AS AN INDICATOR OF WATER QUALITY IN WILDLAND STREAMS,
Malheur National Forest, John Day, OR.
C. C. Bohn, and J. C. Buckhouse.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 95-97, January-February, 1985. 1 Fig, 32 Ref.

Descriptors: *Indicator organisms, *Coliforms, *Streams, Animal wastes, Bacteria, Water quality, Water pollution control, Nonpoint pollution sources, Giardia.

With renewed interest in nonpoint pollution sources and the growing interest in riparian zone management, land management agencies have increased the number of monitoring and research programs on wildland streams. While the cause remains unknown, coliform populations exhibit daily and annual cycling. Regardless of the specific peak periods, the implication of these fluctuations to management and research programs is clear: individual samples represent the sanitary status of a stream only at the time of sampling. Coliforms enter streams with overland flow during the runoff season. They may also enter streams from groundwater flow following storms. The final and most obvious source of fecal coliforms in surface water is direct contamination from animals defecating into the water. Coliform counts are a valid indication of the sanitary status of a body of water only if pathogens respond to these situations in the same way as the coliform bacteria, which is a question to be answered. Coliforms are not satisfactory indicators for the protozoan Giardia spp., which is a growing concern in wildland waters. Fecal coliform and the salmonella species behave very much alike in natural waters. But both may die off while other pathogens remain viable. (Baker-IVI)
W85-05958

INORGANIC CARBONATE ELIMINATION FROM WATER SAMPLES FOR DISSOLVED ORGANIC CARBON ANALYSIS,
Yamagata Univ. (Japan). Dept. of Chemistry.
Y. Satoh, H. Tokairin, and M. Itoh.
Japanese Journal of Limnology, Vol. 45, No. 4, p 318-321, October, 1984. 2 Fig, 2 Tab, 2 Ref.

Descriptors: *Chemical analysis, *Organic carbon, *Dissolved solids, *Carbonates, Wet combustion, Sampling, Carbon dioxide, Water analysis.

Wet combustion is a widespread method for determining dissolved organic carbon (DOC) in both fresh and sea water. When water samples for DOC analysis are sealed into ampules in the field, a method is needed to eliminate inorganic carbonate. In this method, inorganic carbonate is eliminated by passing CO2 and organic free air through acidified samples for DOC analysis. The air is supplied from a manual rubber air pump by way of two gas washing bottles containing concentrated sulfuric acid and 1N-NaOH and a soda lime tube. The precision of the present method is the same as that of the standard method using nitrogen gas from a high pressure nitrogen gas tank. The method is especially useful in remote areas such as alpine lakes. The system can supply CO2-free air with a flow rate of about 200 ml/min for at least 31 hr. (Moore-IVI)
W85-06002

LOCATING CONTAMINANTS IN A GROUNDWATER SYSTEM BY DIRECT CURRENT RESISTIVITY TECHNIQUE,
Kwara State Coll. of Technology, Ilorin (Nigeria). School of Mines.
D. A. Alao.
Bulletin of the Association of Engineering Geologists, Vol. 22, No. 1, p 95-100, February, 1985. 3 Fig, 4 Tab, 9 Ref.

Descriptors: *Electrical resistivity, *Groundwater pollution, *Michigan, Copper mines, Conductivity, Mine wastes, Hydrogeology, Water pollution sources, Mines.

Water is being tapped from a mine shaft at Champion Mine (Painesdale, Michigan) to serve a growing population in the Michigan Copper District. The aims of this project are: to locate groundwater aquifers below piles of mine waste at the abandoned copper mine; to confirm the existence of chemical pollution of groundwater by the mine waste and other possible sources; to achieve the foregoing objectives by means of resistivity studies and application of computer models. Reconnaissance, resistivity measurement (using the Schlumberger Configuration) in the field, and interpretation was supplemented with conductivity data of water samples collected at different sites. Apart form station 2 where there is little or no interference due to potential from extraneous sources, data from other stations were erratic, possibly due to buried conduits, concrete slabs, iron and steel junk, an old railroad which passes through the mine, and site topography. The good sounding data from resistivity station 2 was modelled with a microcomputer. Ground-water pollution would be expected to be indicated by high conductivities and low resistivities; in fact both high values of conductivity and low resistivity are seen at stations 2 and 3. The technique of resistivity and water chemistry has been found suitable for investigating this engineering geology problem. (Moore-IVI)
W85-06015

EFFECT OF ORGANIC SUBSTANCES ON THE RESULTS OF ANODIC STRIPPING VOLTAMMETRY DETECTION OF METAL IONS IN AQUEOUS MEDIA,

Sverdlovsk Inst. of National Economy (USSR).
Kh. Z. Brainina, R. M. Khanina, and L. I. Roitman.
Analytical Letters, Vol. 18, No. A2, p 117-134, February, 1985. 4 Fig, 2 Tab, 14 Ref.

Descriptors: *Metals, *Anodic stripping voltammetry, *Organic compounds, Pollutant identification, Water analysis, Natural waters, Fulvic acids, Humic acids, Enzymes, Polyethylene glycol, Lead, Copper, Cadmium.

The d.c. anodic stripping voltammetry method has been used to investigate the effect of organic substances simulating the composition of natural waters on the results of determination of concentration levels of copper, lead and cadmium. The response, sensitivity and concentration (the latter determined by the standard additions method) have been used as sources of information. In the presence of enzymes, fulvic acids, humic acids and polyethylene glycol all these three parameters change in the case of determination of copper and lead, making the results unreliable. The determination of cadmium concentration is not hampered by the organic substances. The change in the response does not provide sufficient grounds to judge the complexation in natural media. These results also indicate that the determination of metal ion concentration in natural waters necessitates the preliminary breakdown of organic components, especially in cases of determination of lead and copper. The analysis of the initial natural water provides information on the concentration level of the labile electroactive metal ion form. (Baker-IVI)
W85-06056

OPTIMIZATION AND EVALUATION OF REDUCTION-AERATION/AMALGAMATION FOR THE ANALYSIS OF MERCURY IN DRINKING-WATER BY COLD-VAPOUR ATOMIC ABSORPTION SPECTROMETRY (CVAAS),

Ghent Rijksuniversiteit (Belgium). Inst. voor Nukleaire Wetenschappen.
E. Temmerman, R. Dumarey, and R. Dams.
Analytical Letters, Vol. 18, No. A2, p 203-216, February, 1985. 4 Fig, 3 Tab, 9 Ref.

Descriptors: *Drinking water, *Mercury, *Reduction-aeration, *Atomic absorption spectrometry, Water analysis, Water quality control, Heavy metals, Pollutant identification, Absorption.

A reduction-aeration method is optimized for the analysis of mercury at the ng/l level in drinking water. The accuracy of the procedure was controlled by spiking samples with known amounts of mercury. The mean recovery for 14 tests, performed with mercury spikes betwen 1 and 8 ng, was 98.8%. In some cases the mercury is not quantitatively recovered from the solution, probably because Hg(2+) is adsorbed by the precipitate formed on the wall of the aeration flasks. After reduction-aeration with SnCl2, the mercury is collected on gold-coated quartz-sand. Next, the absorbing tube is connected to a second absorber which is continuously linked up with the spectrometer. The mercury is transferred to the second trap by electrothermally heating the first absorbing tube. Final determination is performed by thermal desorption of the second absorber. The procedure can be used directly to analyze mercury in drinking water. Application to other types of water requires a preliminary filtration step in the analytical scheme. (Baker-IVI)
W85-06057

ACID PRECIPITATION: NATURAL VERSUS ANTHROPOGENIC COMPONENTS,

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W85-06060

ACID RAIN: CRITICAL REVIEW OF MONITORING BASELINES AND ANALYSES,

V. Smil.
Power Engineering, Vol. 89, No. 4, p 59-63, April, 1985. 6 Fig.

Descriptors: *Acid rain, *Monitoring, *Reviews, Acidity, Precipitation, Water analysis, Chemical analysis, Sulfates, Nitrates.

Major milestones of the acid rain matter are reviewed for the purpose of showing where it currently stands and where it is heading. Measurement problems have always existed in this area as assessments of regional acidification must be based on comparisons of current data with historical data. Changes in sampling techniques, advanced technologies enabling determination at smaller and smaller quantities, and other developments have caused problems in determining a base line. Another problem has been the interpolation of data across distances of hundreds of miles. The acidity of solutions themselves is a complicated issue with the degree of acidity being determined not simply by the concentrations of sulfates and nitrates, but the complex influences of many cations and anions as well. (Baker-IVI)
W85-06126

DETERMINATION OF THE CONCENTRATION OF MALTOSE- AND STARCH-LIKE COMPOUNDS IN DRINKING WATER BY GROWTH MEASUREMENTS WITH A WELL-DEFINED STRAIN OF A FLAVOBACTERIUM SPECIES,

Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
D. Van Der Kooij, and W. A. M. Hijnen.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 765-771, April, 1985. 7 Fig, 4 Tab, 10 Ref.

Descriptors: *Chemical analysis, *Maltose, *Starches, *Drinking water, *Bacterial physiology, *Flavobacterium, Coagulants, Water treatment.

The growth kinetics of Flavobacterium sp. strain S12 specialized in the utilization of glycerol, and a number of oligo- and polysaccharides were determined in batch-culture experiments at 15 C in pasteurized tap water supplied with very low amounts of substrates. K(sub s)s for the growth on maltotriose, maltotetraose, maltopentaose, and maltohexaose were 0.03 micro M or less and below those for glucose (1.5 micro M) and maltose (0.16 micro M). K(sub s)s for starch, amylose, and amylopectin were 8.4, 25.6, and 11.0 micro g of C per liter, respectively. A yield of 2.3 x 10 to the 7th power CFU/micro g of C on the oligo- and polysaccharides was calculated from the linear relationships observed between maximum colony counts in pasteurized tap water and the concentrations (usually below 25 micro g of C per liter) of supplied compounds. The maximum colony counts of strain S12 grown in various types of raw water and tap water revealed that raw water contained only a few micrograms of maltose- and starch-like compounds per liter; in tap water the concentrations were all below 1 micro g of C and usually below 0.1 micro g of C per liter. The application of starch-based coagulant aids gave increased concentrations of maltose- and starch-like compounds in the water during treatment, but these concentrations were greatly reduced by coagulation and sedimentation, rapid sand filtration, and slow sand filtration. (Author's abstract)
W85-06139

EFFECTS OF BENTONITE CLAY SOLIDS ON POLIOVIRUS CONCENTRATION FROM WATER BY MICROPOROUS FILTER METHODS,

North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. D. Sobsey, and T. Cromeans.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 795-798, April, 1985. 3 Tab, 20 Ref. EPA grant R806677.

Descriptors: *Bentonite clay, *Clays, *Poliovirus, *Microporous filters, *Viruses, *Filtration, Water treatment, Suspended solids.

To determine whether suspended solids interfere with enteric virus recovery from water by microporous filter methods, the effects of bentonite clay solids at a concentration of 10 nephelometric turbidity units on the recovery of poliovirus type 1 from seeded, activated carbon-treated, filtered tap water were studied. Volumes (500 ml) of virus-laden water at pH 5.5 or 7.5, with and without 50 mM MgCl2, were filtered through 47-mm-diameter, electropositive (Virosorb 1MDS) and electronegative (Filterite) filters that had been pretreated with Tween 80 to minimize direct virus adsorption to filter surfaces. Bentonite solids enhanced virus retention on both types of filters, even under conditions in which viruses were not solids associated. However, bentonite solids also interfered with elution of retained viruses when eluting with 0.3% beef extract-50 mM glycine (pH 9.5). Under some conditions, overall virus recoveries were lower from water with bentonite solids than from solids-free control water. The results of this study indicate that clay turbidity can interfere somewhat with virus recovery by current microporous filter methods. (Author's abstract)
W85-06141

FLUOROMETRIC DETERMINATION OF THE DNA CONCENTRATION IN MUNICIPAL DRINKING WATER,

California Univ., Irvine.
W. F. McCoy, and B. H. Olson.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 811-817, April, 1985. 4 Fig, 6 Tab, 29 Ref.

Descriptors: *Deoxyribonucleic acid, *Drinking water, *Bacterial analysis, Chemical analysis, Water analysis, Fluorimetry.

DNA concentrations in municipal drinking water samples were measured by fluorometry, using Hoechst 33258 fluorochrome. The concentration, extraction, and detection methods used were adapted from existing techniques. The method is reproducible, fast, accurate, and simple. The amounts of DNA per cell for five different bacterial isolates obtained from drinking water samples were determined by measuring DNA concentration and total cell concentration (acridine orange epifluorescence direct cell counting) in stationary pure cultures. The relationship between DNA concentration and epifluorescence total direct cell concentration in 11 different drinking water samples was linear and positive; the amounts of DNA per cell in these samples did not differ significantly from the amounts in pure culture isolates. Significant linear correlations between DNA concentration and colony-forming unit concentration were found, as well as between epifluorescence direct cell counts and colony-forming unit concentration. DNA concentration measurements of municipal drinking water samples appear to monitor changes in bacteriological quality at least as well as total heterotrophic plate counting and epifluorescence direct cell counting. (Author's abstract)
W85-06142

METHOD OF DETERMINING AND REMOVING SULPHIDE TO ALLOW THE DETERMINATIONS OF SULPHATE, PHOSPHATE, NITRITE AND AMMONIA BY CONVENTIONAL METHODS IN SMALL VOLUMES OF ANOXIC WATERS,

Commonwealth Scientific and Industrial Research Organization, Hobart (Australia). Marine Labs.
D. Airey, G. Dal Pont, and G. Sandars.
Analytica Chimica Acta, Vol. 166, p 79-92, December, 1984. 4 Fig, 3 Tab, 30 Ref.

Descriptors: *Sulfides, *Sulfates, *Phosphates, *Nitrites, *Ammonia, *Water chemistry, Anaerobic conditions, Spectrophotometry, Water analysis, Interstitial water.

Mercury(II) chloride is used to precipitate free sulfides from < 10-ml samples of anoxic water. The sulfide-free supernatant solution can be used for estimation of sulfide by measuring the concentration of unreacted mercury(II) ion and for determinations of sulfate, inorganic, phosphate, ammonia and nitrite by spectrophotometric methods which normally cannot be used because of sulfide interference. Concentrations that can be determined lie within the ranges: sulfide 0.5-180,000

micro-g S/l, sulfate 0.024-2.77 g S/l, ammonia 1-70,000 micro-g N/l, nitrite 1-3000 micro-g N/l, inorganic phosphate 1-4000 micro-g P/l. Interstitial waters from estuarine sediments, tidal flats, mangrove swamps, and an anoxic estuarine basin were examined. (Author's abstract)
W85-06163

DETERMINATION OF TOTAL PHTHALATE ESTERS IN WASTEWATERS BY DIFFERENTIAL PULSE POLAROGRAPHY,
Kanto Gakuin Univ., Yokohama (Japan). Faculty of Engineering.
K. Tanaka, and M. Takeshita.
Analytica Chimica Acta, Vol. 166, p 153-161, December, 1984. 5 Fig, 2 Tab, 21 Ref.

Descriptors: *Phthalate esters, *Wastewater analysis, *Differential pulse polarography, Polarography, Phthalic acid,.

A reliable procedure for the determination of total phthalate esters as phthalic acid in environmental samples is based on differential pulse polarography (d.p.p.). The phthalate esters are extracted from the sample water with hexane; concentrated sulfuric acid/hexane partitioning provides effective removal of organic interferences. The individual phthalate esters are hydrolyzed by refluxing with 10 M potassium hydroxide to phthalic acid, which is extracted with ethyl acetate followed by evaporation of the extract. This procedure gives recoveries of 83-90%. The residue is dissolved in 0.1 M acetic acid/0.1 M potassium chloride for d.p.p. The optimal conditions for polarography are discussed. The calibration graphs are linear over the range 0.000002 x 0.0001 M and the detection limit for phthalic acid is 0.0000005 M. The method was successfully applied to determine total phthalate esters over the range 0.3-30 micro-g/l in crude and treated wastewaters. (Author's abstract)
W85-06164

LEAD AND CADMIUM IN WADERS FROM THE DUTCH WADDEN SEA,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
For primary bibliographic entry see Field 5C.
W85-06170

5B. Sources Of Pollution

EFFECTS OF A SEWAGE LAGOON EFFLUENT ON THE WATER QUALITY OF THE RECEIVING STREAM,
Ife Univ. (Nigeria). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W85-05851

HYDROCARBONS AND HALOGENATED HYDROCARBONS IN COASTAL WATERS OF THE ENGLISH CHANNEL AND THE NORTH SEA,
IFREMER, Brest (France).
For primary bibliographic entry see Field 5A.
W85-05862

SULFUR DISTRIBUTION IN LAKE SEDIMENT PROFILES AS AN INDEX OF HISTORICAL DEPOSITIONAL PATTERNS,
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
M. J. Mitchell, M. B. David, and A. J. Uutala.
Hydrobiologia, Vol. 121, No. 2, p 121-127, February, 1985. 2 Fig, 2 Tab, 36 Ref. NSF grant DEB-18-10641.

Descriptors: *Sulfur, *Lake sediment, *Paleolimnology, *Acidic deposition, *Sedimentation, *South Lake, *New York, *Ledge Pond, *Maine, Seston, Isotope studies, Radioisotopes, Sulfur radioisotopes, Lead radioisotopes, Acid lakes.

There has been no previous attempt to link the sulfur budget of a lake to paleolimnological information on S in sediment. Changes in S concentration in sediment profiles from South Lake (Adirondack region, New York) and Ledge Pond (western Maine) indicated an increased input of S beginning 1850. This S was probably derived from anthropogenic sources. The present pH of South Lake ranges from 4.9-5.4. A sediment core was obtained from South Lake by divers on July 5, 1982 from a depth of 18 m. The activity of Pb-210 and total S content were determinded for each interval above 20 cm and select intervals below this depth. Pb-210 was determined via its granddaughter isotope, Po-210. Sediment traps were installed in April 1981 at three depths which were in the epilimnion, metalimnion, and hypolimnion of mid-summer. Samples were collected every 3-4 weeks from April to November during 1981-82. The S budget of South Lake indicated that sedimentation of seston rich in S (approximately 0.9% dry mass) accounts for most of the input of S in sediment. Sulfur in both seston and sediment is primarily organic (57 and 22% ester sulfate, 32 and 52% carbon-bonded S, respectively). The transformation and translocation of organic S constitutes a major pathway of S flux in South Lake. For South Lake with a turnover of 0.5/a and a volume of 2.63 x 10 to the 10th power L, 670,000 mol S/a would be exported from the lake if uniform S concentration is assumed. If S deposition is extrapolated for the entire lake, sedimentation would account for 34,000 mol S/a which would equal 5% of the S input to the lake. Increased understanding of those factors which affect S sedimentation will enhance understanding of freshwater systems since changes in this process, as reflected in the S profile in sediment, may serve as indices of important limnological phenomena such as acidification. (Collier-IVI)
W85-05865

CONCEPTUAL MODEL OF UNIT-MASS RESPONSE FUNCTION FOR NONPOINT SOURCE POLLUTANT RUNOFF,
Padua Univ. (Italy). Faculty of Engineering.
F. Zingales, A. Marani, A. Rinaldo, and G. Bendoricchio.
Ecological Modelling, Vol. 26, No. 3/4, p 285-311, December, 1984. 16 Fig, 46 Ref.

Descriptors: *Runoff, *Nonpoint pollution sources, *Model studies, *Mathematical studies, *Venice Lagoon, *Italy, Rainfall-runoff relationships, Path of pollutants.

A conceptual mathematical model of unit-mass response function (UMRF) of nonpoint source pollutants (NPSP) was developed. The physical aspects of the mathematics involved yield explanation of some basic mechanisms observed in nature for various environmental responses, like inherent hysteretical effects (rising-falling flow dependence) and linear pollutant load/discharged water volume correlations. The mathematical model substantiates screening or planning modelling techniques proposed in the literature, provided that reference weighted pollutant concentrations in the runoff are used. A conceptual form of such an average concentration arises also from the mass transfer and balance relationships investigated. The model is designed to portray consistent NPSP balances (with interphase mass transfer) via an extension of Nash's conceptual scheme of rainfall-runoff transformations. The limited number of parameters and their clear physical meaning make this approach suitable to NPSP simulation and forecasting. The derived form of UMRF is simple, thus calling for microcomputer software applications. Although the proposed model structure consists of lumped parameter formulation, the approach may serve as an alternative to empirical routing procedures often implemented in distributed parameter codes. The techniques adopted make use of standard mathematics of hydrological and chemical models, and therefore the related high degree of sophistication developed for simulation and forecasting can be exploited by the present approach for ecological modeling. Results of applications to the case study of the Venice Lagoon (Italy) are presented and discussed. (Author's abstract)
W85-05872

EFFECT OF IRRIGATION PRACTICES IN THE BREE RIVER VALLEY ON THE SALT CONTENT OF A SMALL RIVER,
Rhodes Univ., Grahamstown (South Africa). Hydrological Research Unit.
J. H. Moolman, P. C. van Rooyen, and H. W. Weber.
Irrigation Science, Vol. 4, No. 2, p 103-116, June, 1983. 3 Fig, 6 Tab, 20 Ref.

Descriptors: *Irrigation-return flow, *Salinity, *Bree River Valley, *South Africa, Water pollution sources, Total dissolved solids, Vineyards, Computer models, Solute transport, Leaching, Irrigation practices.

The effect of varying irrigation return flow volumes as a possible explanation for the fluctuations in the mean monthly baseflow total dissolved solids (TDS) content of the Poesjesnel River, a tributary in the Bree River Valley, South Africa, was investigated. A conceptual computer model was used to simulate the movement of water and solutes in 769 ha of soil in an area where vineyards are irrigated intensively. Important input requirements of the model are the physical and chemical properties of the irrigated soils, consumptive use data, and root distribution patterns. The computer model predicts that the present system of irrigation in the Poesjesnel River Valley results in significant amounts of salts being leached out of the soil during the early stages of the irrigation season from August to November. This period of high leaching coincides with an increase in the observed TDS content of the receiving river. When peak water demand sets in, very little leaching takes place and soluble salts accumulate in the soil. In dry years it is possible for this salt buildup stage to continue until May. The period of salt accumulation in the soil again concides with a decrease in the observed TDS content of the river. Therefore, irrigation return flow plays an important role in the mineralization of the Poesjesnel River. On a semi-annual time basis, the model was able to simulate and quantify the mineralization processes to a fair degree of accuracy. (Baker-IVI)
W85-05928

PRIMER ON NONPOINT POLLUTION,
Wisconsin Univ.-Madison. Dept. of Soil Science.
G. Chesters, and L.-J. Schierow.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 9-13, January-February, 1985. 2 Fig, 13 Ref.

Descriptors: *Nonpoint pollution sources, *Reviews, Legislation, Agricultural chemicals, Animal wastes, Pesticides, Nutrients, Eutrophication, Sediments, Metals.

Research was initiated on the causes and consequences and control of nonpoint pollution in response to passage of the Water Pollution Control Act Amendments of 1972. Interest in nonpoint pollution seemed to wane after 1979, possibly due to a belief that sufficient pollution control could be achieved by managing only point sources; an understanding that pollutant load reductions could be achieved more economically by controlling point sources; or a decrease in federal funding for research on management techniques. A recent resurgence of interest has been noted. Nonpoint pollution enters the environment from diffuse sources. Sources vary among geographic regions. From all sources of nonpoint pollution, sediment comprises the greatest volume by weight of materials transported. Other than sediment, the pollutants of greatest concern from rural sources are plant nutrients, which are responsible for lake and stream eutrophication. The dynamics of nonpoint pollution discharges are as equally important as the sources of water pollution. The magnitude of nonpoint pollution is considered including sediment, nutrients, pesticides, toxic metals, livestock and sewage wastes, land conversion, and atmospheric pollutants. (Baker-IVI)
W85-05939

NONPOINT SOURCES OF WATER POLLUTION,
Environmental Protection Agency, Washington, DC. Nonpoint Sources Branch.
C. F. Myers, J. Meek, S. Tuller, and A. Weinberg.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 14-18, January-February, 1985. 1 Tab, 11 Ref.

Descriptors: *Nonpoint pollution sources, *Reviews, Highways, Construction, Farming, Mining, Forestry, Agriculture, Pesticides, Urban runoff, Water pollution sources, Land use.

Among the important sources of nonpoint pollutants nationally are agricultural, mining, urban, construction, and silvicultural sources. As is the case with most types of nonpoint source pollution, agricultural nonpoint source pollution relates directly to the way in which land is used. Sediment from cropland is a major potential cause of water pollution. Even so, agricultural pollution reduction is achievable. Substantial water quality benefits can be achieved by carefully targeting resources to land areas and activities that are the source of agriculturally generated pollution problems. In the field of mining, each mineral has its own set of nonpoint source problems. Mining nonpoint sources include discharges from inactive mining operations as well as runoff from inactive road networks and old tailings and spoil piles. Urban nonpoint sources include rainwater running off roofs, lawns, streets, industrial sites, and other areas. On a national basis, the nonpoint source water pollution resulting from construction activities is not nearly as great as that caused by other major nonpoint sources. Where construction activities are intensive, the localized impacts on water quality may be severe because of the high unit loads involved. Highway construction and other heavy development account for most of this type of nonpoint source. Forestry management activities, which are of a local nature, can be a real problem where they are part of the industry of the region. (Baker-IVI)
W85-05940

SALINITY POLLUTION FROM IRRIGATED AGRICULTURE,

World Resources Inst., Washington, DC.
M. T. El-Ashry, J. Van Schilfgaarde, and S. Schiffman.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 48-52, January-February, 1985. 2 Fig, 24 Ref.

Descriptors: *Salinity, *Agriculture, *Water pollution sources, *Irrigation practices, Crop yields, Water pollution control, Semiarid regions.

Progress in regional salinity control has been disappointing. The delay in implementing control measures, where they have been planned, is not because of the lack of technically feasible or cost-effective measures. It is primarily because of political opposition from those who contribute the most to downstream salinity. Potentially effective salinity control measures have been skirted because those who would pay for them do not envision any benefits for themselves in return. Irrigation-related salinity is the major water quality problem in the semiarid western states, where significant quantities of salts occur naturally in rocks and soils. In all affected river basins, salinity as progressively increased as water resources have been developed and put to use. The water in these rivers also becomes increasingly saline from the headwaters to the mouths. Many technologies and techniques for reducing salinity exist at varying costs. These involve increases in the efficiency of irrigation water application, reductions in irrigation water losses from conveyance systems through seepage, disposal of saline agricultural return flows, or desalination of saline drainage water. Legal, institutional factors involved in the problem are briefly considered. (Baker-IVI)
W85-05945

REGIONAL WATER QUALITY IMPACTS OF INTENSIVE ROW-CROP AGRICULTURE: A LAKE ERIE BASIN CASE STUDY,

Heidelberg Coll., Tiffin, OH. Water Quality Lab.
D. B. Baker.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 125-132, January-February, 1985. 6 Fig, 5 Tab, 39 Ref.

Descriptors: *Lake Erie Basin, *Water pollution sources, *Crop production, Water quality management, Conservation tillage, Phosphorus, Nitrates, Herbicides, Agricultural runoff, Potable water.

Intensive row-crop agriculture dominates land use in the northwestern Ohio River basins draining into Lake Erie. Detailed, long-term studies of water quality in these rivers reveal high unit-area P loads entering Lake Erie, even though gross erosion rates are relatively low. Concentrations of nitrate-N and currently used herbicides are also high from May through July, both in surface waters and in public water supplies derived therefrom. To reduce P loading to Lake Erie, water quality management agencies are advocating adoption of conservation tillage. Conservation tillage could increase nitrate and herbicide contamination of area waters. This region's detailed baseline nutrient and herbicide data provide an opportunity to evaluate the effects of conservation tillage on a variety of water quality parameters. To separate weather-related from management-related effects, an ecosystem approach is advocated. (Author's abstract)
W85-05962

DISSOLVED NITROGEN AND PHOSPHORUS IN RUNOFF FROM WATERSHEDS IN CONSERVATION AND CONVENTIONAL TILLAGE,

Agricultural Research Service, Columbia, MO. North Central Watershed Research Unit.
E. E. Alberts, and R. G. Spomer.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 153-157, January-February, 1985. 7 Fig, 1 Tab, 12 Ref.

Descriptors: *Nitrogen, *Phosphorus, *Agricultural runoff, *Tillage, *Iowa, Conservation tillage, Agricultural watersheds, Fertilizers, Storm seepage, Surface flow, Water pollution sources.

Dissolved N and P concentrations in surface and subsurface flows were measured from three corn-cropped watersheds in southwestern Iowa from 1974 through 1983. One watershed was tilled conventionally while the other two were till-planted, all on the contour. One of the till-planted watersheds was terraced, with underground pipe drains to remove excess water from the terrace channels. Each of the watersheds was fertilized at recommended N and P levels for optimum corn production. Losses of NO3-N, NH4-N, and PO4-P in surface runoff were low, representing less than 2% of the annual fertilizer application. However, NO3-N and NH4-N concentrations in surface runoff from the till-planted watersheds sometimes exceeded water quality standards. PO4-P in surface runoff from each of the watersheds always exceeded the water quality standard, and was especially high from the till-planted watersheds. NO3-N losses in subsurface flow represented more than 85% of the total NO3-N losses in both subsurface and surface flows. The highest annual NO3-N loss in subsurface flow was 74.4 kg/ha (66.4 pounds/acre) from the nonterraced, till-planted watershed in 1983. NO3-N concentrations in subsurface flow from this till-planted watershed have exceeded the water quality standard since 1977. (Author's abstract)
W85-05968

CONSERVATION PRACTICE EFFECTS ON PHOSPHORUS LOSSES FROM SOUTHERN PIEDMONT WATERSHEDS,

Agricultural Research Service, Watkinsville, GA.
G. W. Langdale, R. A. Leonard, and A. W. Thomas.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 157-161, January-February, 1985. 1 Fig, 4 Tab, 30 Ref.

Descriptors: *Soil conservation, *Phosphorus, *Piedmont, *Water pollution sources, Nonpoint pollution sources, Tillage, Conservation tillage, Agricultural runoff, Crop production.

Conservation and conventional tillage systems were used on small, upland watersheds in the Southern Piedmont to determine P contributions to nonpoint-source water pollution. Six tillage/cropping systems were studied on three watersheds over a 10-year period. Each tillage/cropping system was repeated every 2 to 4 years over a range of conservation practices and related to both C and P factors of the USLE. Total P runoff losses varied from 0.1 to 4.0 kg/ha/yr and consistently related to soil loss within each tillage system, irrespective of watershed landscape and the conservation practice imposed. The soluble-P fraction, PO4-P, and total dissolved P increased dramatically from about 10% to 40% of total P as multiple cropping and the use of conservation tillage intensified with respect to crop residue cover. Although higher concentrations of both soluble P and total P were usually associated with conservation tillage, total P losses declined 50% or more while soluble P losses were nearly equal to or less than those measured for conventional tillage. These reductions in total P were the result of lower runoff volume with conservation tillage. (Author's abstract)
W85-05969

RUNOFF, SOIL, AND NUTRIENT LOSSES FROM RANGELAND AND DRY-FARMED CROPLAND IN THE SOUTHERN HIGH PLAINS,

Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
O. R. Jones, H. V. Eck, S. J. Smith, G. A. Coleman, and V. L. Hauser.

Journal of Soil and Water Conservation, Vol. 40. No. 1, p 161-164, January-February, 1985. 1 Fig, 4 Tab, 9 Ref.

Descriptors: *Rangeland, *Cropland, *Soil erosion, *Nutrients, *Runoff, High Plains, Conservation tillage, Terracing, Nitrogen, Phosphorus, Fallowing, Contours, Agricultural watersheds.

The erosion potential of rainfall in the semiarid Southern High Plains is much less than in more humid area, but large, intense storms have the potential to cause severe erosion on cropland and to contribute to nonpoint-source pollution. A study site was selected which has climate, topography, and soils representative of about 4.8 million ha of cropland and rangeland in the Southern High Plans. Runoff was measured on two rangeland and three adjacent cultivated watersheds. With conservation tillage on the contour and graded terraces, erosion was less than the soil loss tolerance (T) during all years of the study. Even in 1978, with more than 51 mm (2.0 inches) of runoff from a single storm and with total annual runoff of 152 mm (6.0 inches), soil loss was only 6.5 t/ha (2.9 tons/acre), well under the T value of 11.2 t/ha (5 tons/acre). Runoff was from three to five times greater from cultivated watersheds than from range watersheds. Annual nitrate-N losses were less than 2 kg/ha for any treatment. The highest total annual Kejldahl N loss was only 11 kg/ha. P losses were also minimal, with a maximum loss of 4.2 kg/ha for the fallow watershed in 1978. N and P losses were much lower than from cultivated watersheds. On the cultivated watersheds, such soil-conserving practices as terracing, contour tillage, and conservation tillage kept sediment and nutrient losses low. (Moore-IVI)
W85-05970

EFFECTS OF LIVESTOCK WASTES AND AGRICULTURAL DRAINAGE ON WATER QUALITY: AN ONTARIO CASE STUDY,

Ontario Ministry of the Environment, London.
S. Thornley, and A. W. Bos.

Journal of Soil and Water Conservation, Vol. 40, No. 1, p 173-175, January-February, 1985. 6 Fig, 1 Tab, 2 Ref.

Descriptors: *Animal wastes, *Drainage water, *Water quality, *Ontario, Water pollution sources, Bacteria, Nutrients, Farms, Attitudes, Economic aspects.

An evaluation of livestock waste management impacts on water quality was carried out in a southwestern Ontario watershed in response to frequent downstream beach closures and fish kills. The 90-

square-mile study site contained more than 300 livestock farms. These farms average 80 animal units per farm. The watershed is immediately upstream from the Gordon Pittock Reservoir, a man-made water conservation area. Bacteria and nutrient levels far exceeded provincial water quality quidelines and objectives at most sampling points. Even in headwater areas, effluent from underground drainage systems showed bacterial and chemical characteristics comparable to domestic sewage. Although the sources or causes of the poor quality water in the tile drains were unknown, illegal connections were suspected as a contributing factor. Such connections may have been occurring in both rural municipalities and the agricultural community in general. A survey of 98 basin farmers showed that ignorance of the problem and economic pressures on livestock producers were major contributing factors. In many cases, rectifying the problem will require large capital expenditures for improved storage and handling facilities. (Moore-IVI)
W85-05973

CHANGE IN PCB (CLOPHEN A 50) COMPOSITION WHEN TRANSPORTED FROM SEDIMENT TO AIR IN AQUATIC MODEL SYSTEMS,
Lund Univ. (Sweden). Limnological Inst.
P. Larsson.
Environmental Pollution (Series B), Vol. 9, No. 2, p 81-94, 1985. 7 Fig, 1 Tab, 37 Ref.

Descriptors: *Fate of pollutants, *Polychlorinated biphenyls, *Sediments, *Air pollution, Volatilization, Jet drop transport, Sediment-water interfaces, Air-water interfaces, Chlorinated hydrocarbons, Bubbles.

The contaminated sediment of lakes and watercourses may act as a source of polychlorinated biphenyls (PCBs) to the atmosphere. A total of 24.8 mg of Clophen A 50 was added to the sediment of each laboratory model system, composed of 9 kg of sediment, 32 liters water, benthic macroinvertebrates and fish. Part of the PCBs left the sediment and a concentration of 0.2-0.7 micro-g/l was obtained in the water. The transport of PCBs from water to air includes at least two processes: volatilization and jet drop transport. Volatilization resulted in a transport of 0.2-1.0 micro-g PCBs a week to air. Less chlorinated PCBs were transported to the air to a greater extent than more chlorine-substituted PCBs. Transport of PCBs by jet drops from bursting bubbles was of the same magnitude as volatilization, but the proportion of PCB compounds volatilized was identical with that in sediment and water. Thr transport of PCBs by jet drops from water to air was probably dominated by a transport of subsurface water and particles. The continuous mixing of the water by microbubbles is important for the volatilization transport of PCBs for the water phase to the air. The limiting process in the transport of PCBs from sediment to air is probably the transfer of PCBs from sediment to water. (Moore-IVI)
W85-05974

FIXATION AND MOBILIZATION OF ANTIMONY IN SEDIMENTS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Brannon, and W. H. Patrick, Jr.
Environmental Pollution (Series B), Vol. 9, No. 2, p 107-126, 1985. 4 Fig, 7 Tab, 21 Ref.

Descriptors: *Antimony, *Path of pollutants, *Sediments, Sediment-water interfaces, Leaching, Aerobic conditions, Anaerobic conditions, Volatile compounds.

The mobility of sediment antimony (Sb) during sediment-water interactions was studied. Emphasis was placed on the fixation of native and added Sb by sediment, long-term (6 months) releases of Sb and sediment properties that affect the mobilization of Sb. Sequential selective extraction procedures revealed that most native and added sediment Sb was associated with relatively immobile iron (Fe) and aluminum (Al) compounds. In sediments amended with Sb, concentrations of interstitial water and exchangeable phase Sb were also high. Initial and long-term releases of Sb were much higher from Sb-amended sediments than from sediments containing no added Sb, apparently a result of Sb concentrations in more mobile sediment phases. In most sediments, the largest amount of Sb release occurred early in the leaching experiment. These results suggest that Sb release from contaminated sediments is more likely to occur during the first few months of sediment-water interaction. During aerobic leaching, Sb moved into a more unavailable sediment phase, decreasing the potential for further releases. Sediment Fe and CaCO3 equivalent concentrations were found to affect releases of added Sb. Evolution of volatile Sb compounds was also noted from sediments under anaerobic conditions. (Author's abstract)
W85-05975

CHARACTERISTICS OF HEAVY METAL DISTRIBUTION IN BOTTOM MUD OF URBAN RIVERS (IN JAPANESE),
Takasaki Coll. of Economics, Gumma (Japan).
F. Tada, J. Suzuki, and S. Suzuki.
Japanese Journal of Limnology, Vol. 45, No. 4, p 296-303, October, 1984. 4 Fig, 4 Tab, 10 Ref.

Descriptors: *Heavy metals, *Rivers, *Urban areas, *Bottom sediments, Mud, Copper, Zinc, Cadmium, Lead, Nickel, Chromium, Particle size, Organic matter, Fate of pollutants.

In order to clarify the distribution pattern of heavy metals contained in the bottom mud of urban rivers, the metals were fractionated by extraction with 2N CH3COONH4 and 0.5N HCl. The total metal content was determined after the decomposition with HNO3-H2O2. A part of the Cu, Zn, and Cd in the bottom mud of urban rivers was extracted with 2N CH3COONH4, but the Pb, Ni and Cr were unextractable. This result indicated that the forms of metals in bottom mud differed from one another. The metal content increased in the lower reaches of the urban river, and the amount of the increased metals was approximately equal to those of the metals extracted with 0.5N HCl. The increase of metals downstream was also correlated to the grain size and the organic matter content of bottom mud. These results suggested that a significant part of the metals in the bottom mud of urban rivers were weakly bound to fine grain size sand and organic matter. (Author's abstract)
W85-06000

NITROGEN MIGRATION IN ZHUJIANG RIVER (IN CHINESE),
Academia Sinica, Guangzhou (China). South China Sea Inst. of Oceanology.
Z. Lin, J. Zheng, and J. Jhu.
Oceanologia et Limnologia Sinica, Vol. 15, No. 6, p 515-520, November, 1984. 5 Fig, 3 Tab, 8 Ref.

Descriptors: *Nitrogen, *Zhujiang River, *China (Peoples Republic), Nutrients, Nitrates, Nitrites, Ammonium, Water pollution sources, *Path of pollutants, Industrial wastes, Fertilizers, Decomposition.

The Zhujiang River (The Pearl River) is the only tropic-subtropical river of considerable magnitude in China. The study of the variation and migration of nitrogen as a nutrient is one of the approaches to the understanding of substance exchange at the river-sea interface. Measurements of the three states of N (NO3-N, NO2-N and NH4-N) in the Zhujiang River basin from Guangzhou to Shanbanzhou Sandbank at the Zhujiang River mouth were for first carried out in summer, 1982. Results were obtained on N content variation and distribution patterns, the relationship of N with environmental factors, as well as the correlation and transformation between different states of N. Nitrogen content in the Zhujiang River water is relatively high. Dissolved inorganic N and NO3-N are 5.2 and 8.9 times those of the world rivers on an average, respectively. It is estimated that flux of the 3 states of N passing through the Humen Mouth might be 15.8 kg/s (by NO3 weight). The main sources of N are soil, industrial effluents, rotten crops and agricultural fertilizers. (Author's abstract)
W85-06010

LAKE ACIDIFICATION IN GALLOWAY: A PALAEOECOLOGICAL TEST OF COMPETING HYPOTHESES,
University Coll., London (England). Palaeoecology Research Unit.
R. B. Battarbee, R. J. Flower, A. C. Stevenson, and B. Rippey.
Nature, Vol. 314, No. 6009, p 350-352, March, 1985. 3 Fig, 2 Tab, 33 Ref.

Descriptors: *Acidification, *Acid precipitation, *Paleoecology, *Galloway, *Scotland, Water pollution sources, Acid rain, Reforestation, Heathland, Pollen analysis, Heavy metals, Copper, Lead, Zinc.

Possible causes of lake acidification in Britain include acid precipitation, heathland regeneration, afforestation and post-glacial natural acidification (long-term change). In Galloway, south-west Scotland, several lakes with non-afforested catchments have been acidified by approximately 1 pH unit since about 1840, which clearly precludes long-term change and afforestation as causes of the present acidity, but does not discriminate between the possible effects of heathland regeneration and acid precipitation; it could be argued that a decline in upland farming in this area led to an increase in acid heathland communities capable of promoting lake acidification during this period of time. Pollen analysis is used to show that there is no evidence for an increase in Calluna vulgaris, the most important heathland species, over the past 200 yr or so, and the acid precipitation hypothesis is substantiated by demonstrating substantial increases of the heavy metals Pb, Cu and Zn in the sediment since about AD 1800. (Author's abstract)
W85-06013

PILOT STUDY OF TRACE METAL MOVEMENT IN SOILS ON HILLSLOPES IN THE COAST RANGES, CALIFORNIA,
Bureau of Reclamation, Sacramento, CA. Mid-Pacific Regional Office.
N. P. Prokopovich.
Bulletin of the Association of Engineering Geologists, Vol. 22, No. 1, p 87-94, February, 1985. 7 Fig, 7 Ref.

Descriptors: *Copper, *Zinc, *Lead, *Leaching, *Coast Ranges, *California, Acid rain, Path of pollutants, Trace metals, Soil chemistry, Slopes, Herbicides.

Due to the buffering action of carbonates, areas underlain by calcareous deposits are in general considered not to be susceptable to acid precipitation. A study initially aimed at establishing the fate of herbicide copper introduced into Solano Reservoir on Putah Creek produced results which indicate that this area may be more susceptible to acid precipitation than previously thought. Chemical testing was carried out on three-normal hydrochloric acid leachates of some 275 grab samples of surface soils, colluvium and alluvium from the rugged forest-chaparral covered watershed of Putah Creek; 17 grab samples of topsoil from the vicinity of Lodoga; and 8 samples of topsoil from the vicinity of Stony Gorge Reservoir in the California Coast Ranges. After detection of possible leaching and downslope migration of copper in soils, the study was extended to three other areas: the divide between Thompson and Bray canyons; the vicinity of Lodoga; and the Stony Gorge Reservoir area. Zinc and lead determinations were added during this stage. There was a general minor increase in copper and lead content in the downslope direction, particularly on smooth, undissected slopes. Zinc content frequently appeared to be erratic. The data indicate the existence of minor regional leaching of such trace metals as copper and lead by natural precipitation. An increase of such leaching by acid rain is conceivable with possible future regional increases of population and pollution. (Moore-IVI)
W85-06014

METAL DISTRIBUTION AND CONTAMINATION IN SEDIMENTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
K. D. White, and M. E. Tittlebaum.
Journal of Environmental Engineering, Vol. 111, No. 2, p 161-175, April, 1985. 3 Fig, 5 Tab, 5 Ref.

Descriptors: *Sediment contamination, *Heavy metals, *Louisiana, Waterways, Lake sediments, Statistical methods, Relative atomic variation, Particle size, Fate of pollutants.

Heavy metals analysis were performed on the sediments from various south Louisiana waterways. Objectives of the study were to determine vertical heavy metal distributions, to evaluate a proposed statistical method used to make qualitative assessments of cultural contamination based on trace metal-conservative metal relationships, and to attempt to determine heavy metal contamination in sampled sediments. Cores were obtained from three distinct areas in south Louisiana. Area 1 consisted of waterways located in heavily industrialized areas. Area 2 consisted of a 110 m deep core obtained just off the present Mississippi River delta. Area 3 samples were obtained from a shallow urban lake. The vertical metal concentration distribution of the deep core revealed very consistent concentrations for metals throughout the entire depth. The relative atomic variation (RAV) method, used to reduce the grain size effects on heavy metal accumulations in sediments by correlating element pairs, was evaluated. The evaluation of the method in this study uncovered serious limitations. Metal contamination was determined by comparing both absolute concentrations and trace metal-conservative metal concentration ratio values to their respective deep core background values. (Author's abstract)
W85-06019

1-D POLLUTANT MIGRATION IN SOILS OF FINITE DEPTH,
University of Western Ontario, London. Faculty of Engineering Science.
R. K. Rowe, and J. R. Booker.
Journal of Geotechnical Engineering, Vol. 111, No. 4, p 479-499, April, 1985. 13 Fig, 25 Ref. Natural Sciences and Engineering Research Council of Canada grants A1007 and G0921.

Descriptors: *Clay, *Liners, *Path of pollutants, *Solute transport, Dispersion, Advection, Geochemistry, Soil properties, Landfills, Groundwater movement, Groundwater pollution, Water pollution control.

A technique for the analysis of 1-D pollutant migration through a clay layer of finite depth includes dispersive and advective transport in the clay as well as geochemical reactions. The technique permits consideration of the depletion of contaminant in the landfill with time as well as the effect of a flushing velocity in a permeable stratum beneath the clay layer. The technique requires minimal data preparation, is accurate, and is computationally very efficient compared with alternative techniques. A limited parametric study illustrates the effect of considering these factors in the analysis. If the base velocity is greater than zero, the concentration of pollutant in the groundwater beneath the liner will reach a maximum value at some time and will decrease for greater times. This maximum value can be used in clay liner design to ensure that the contamination of the groundwater never exceeds a specified level. The magnitude of the peak concentration and the time required for it to occur are highly dependent upon the mass of contaminant within the landfill and the sorption capacity of the clay. The thickness of the clay layer, advection velocity (relative to the dispersivity), and the ground-water flow velocity in any permeable strata beneath the clay layer are also important factors. The maximum base concentration can be decreased by increasing clay liner thickness. The design of the liner may be optimized by also considering the effects of leachate height, base velocity and any geochemical reaction. (Moore-IVI)
W85-06024

NITROGEN AND PHOSPHORUS EXPORTATION IN THE GARONNE BASIN (FRANCE),
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
J. L. Probst.
Journal of Hydrology, Vol. 76, No. 3/4, p 281-305, February, 1985. 14 Fig, 8 Tab, 66 Ref.

Descriptors: *Garonne Basin, *Girou Basin, *France, *Nitrogen, *Phosphorus, Cycling nutrients, Nutrients, Fetilizers, Agricultural watersheds, Suspended sediments, Water pollution sources, Nonpoint pollution sources, Storm seepage.

Nitrogen balance was determined in two basins of the southwest of France: the Garonne (52,000 sq km) and one of its tributaries, the Girou (520 sq km). Phosphorus balance was estimated only in the Girou watershed. Water samples were collected from 1971 through 1981. The nitrogen and phosphorus export from the two agricultural watersheds depend on two main factors: the quantity and the origin of the inputs in the watersheds; and the annual rainfall height, the intensity of the surface runoff and soil leaching. The greater these two factors are, the more the export rate increases. The annual discharge-concentration relationships and the behavior of the concentrations during storm events show that nitrogen and phosphorus are both of superficial origin. The separation of the three components in the storm hydrograph and the application of the mixing models yields an estimate of 130 mg/l for nitrate concentration in subsurface waters during wintertime and 60 mg/l during summer. The phosphorus concentration in the surface waters is about 0.5 mg/l TP. The dilution factor appears the same for nitrogen as for phosphorus. The annual nitrate contributions of the subsurface flow have been estimated at about 50-60% of the annual stream flux. The surface flow represents only 15% of the annual streamflow and occurs during a relatively short period of time, 50 days a year. The phosphorus losses from agricultural lands are mainly transported by the surface runoff which represents only 8.6% of the total annual streamflow. In the river waters, there is a good relationship between the phosphorus concentrations and the suspended sediments. The export rate of nonpoint source pollution is lower than 1%. The phosphorus fertilizers applied are accumulated in the soil. The annual contributions of the different phosphorus sources to the river export are estimated at 7% from natural biogeochemical processes, 32% from nonpoint pollution and 61% from point pollution. (Baker-IVI)
W85-06049

INTERFLOW OF WATER AND TRACER CHEMICAL ON SLOPING FIELD PLOTS WITH EXPOSED SEEPAGE FACES,
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
O. R. Lehman, and L. R. Ahuja.
Journal of Hydrology, Vol. 76, No. 3/4, p 307-317, February, 1985. 4 Fig, 5 Tab, 11 Ref.

Descriptors: *Soil water, *Seepage, *Path of pollutants, Infiltration, Porosity, Soil properties, Tracers, Agricultural chemicals, Storm seepage, Interflow, Temperature effects.

Four experimental field plots, each 1.8 m wide and 80 m long on 6-8% slopes, were isolated from each other and the surrounding area by sheet metal plates extending from 0.15 m above to 0.9 m below the surface of a Typic Paleudults soil. An open soil face about .7 m deep, divided into three natural horizons, formed the lower end of each plot in a runoff monitoring pit. The plots were used to measure water and tracer chemical flows when simulated rainfall was applied at rates of 1.5 - 2.5 cm/hr to soil that was initially either nearly saturated, or initially near the wilting point for the grass cover. Potassium bromide solution was used to trace the face of a surface applied mobile chemical. The plot surface area contributing to the interflow of water and subsurface transport of agricultural chemicals was located near the outflow face. This suggests that chemical transport in interflow and runoff might be substantially reduced by appropriate management of relatively small soil surface and volumes. The steady interflow rates for water were not appreciably affected by initial soil moisture conditions. Initially dry soil moisture conditions resulted in rapid deep infiltration of most surface applied bromide, and markedly less total bromide was transported in runoff and interflow as compared with initially saturated conditions. In one particular experiment, the initial soil moisture was at saturation and temperature of the water regime was about 11 C cooler than for the other experiments. There was markedly less infiltration and a higher runoff rate that transported more total bromide. Under certain conditions, the temperature of the water regime may be an important factor in models predicting the potential interflow of water and chemicals. (Baker-IVI)
W85-06050

IMPACT OF BRIDGING ON FLOODPLAINS,
For primary bibliographic entry see Field 6G.
W85-06067

PESTICIDE POLLUTION PROBABILITIES,
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
W. C. Mills, and R. A. Leonard.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1704-1710, November-December, 1984. 5 Fig, 3 Tab, 13 Ref.

Descriptors: *Pesticides, *Path of pollutants, *Probabilities, Mathematical studies, Model studies, Rainfall-runoff relationships, Source of pollutants.

A procedure for obtaining probabilities for pesticide pollution of water was developed. Central in the development of this procedure is the derivation of a stochastic pesticide state model in the form of a probability density function for amount of pesticide on crop foliage or soil available for runoff upon the occurrence of significant rainfall. A recursive algorithm derived from generating functions was proposed for coupling the stochastic pesticide state model to stochastic models for rainfall and watershed state and deterministic models for event runoff of water, sediment, and pesticide and environmental damage. Associated risk evaluations are discussed. (Author's abstract)
W85-06075

LONG-TERM SURVIVAL OF HUMAN ROTAVIRUS IN RAW AND TREATED RIVER WATER,
Ottawa Univ. (Ontario). Dept. of Microbilogy and Immunology.
R. A. Raphael, S. A. Sattar, and V. S. Springthorpe.
Canadian Journal of Microbiology, Vol. 31, No. 2, p 124-128, February, 1985. 2 Fig, 1 Tab, 35 Ref.

Descriptors: *Rotavirus, *Fate of pollutants, *Viruses, Microorganisms, Infection, Survival.

This study was aimed at assessing the role of water as a vehicle for rotavirus spread by determining how well these viruses survive in the water environment. A cell culture adapted strain of human rotavirus subgroup 2, grown in MA-104 cells, was used as a model. Virus survival was tested in the following types of water samples, derived from the Ottawa River, at two different times of the year: (i) raw water (RW), (ii) municipally treated tap water (TW), and (iii) raw water that had been filtered (FW) through a membrane (0.22 micro m). The water samples, with approximately 50,000 plaque-forming units (PFU) of the virus, were held at either 4 or 20 C and tested for infectious virus over a period of 64 days. The TW samples had a total and free chlorine content of 0.05 and < 0.05 mg/L, respectively. The chlorine in these samples was not neutralized before virus contamination. Irrespective of the holding temperature, the virus titer in FW remained essentially unaltered throughout the test period. In TW held at 4 C, there was no significant drop in the virus in the titer even after 64 days, whereas at 20 C the titer in TW was reduced by about 2 log over the same period. Even though the loss of virus infectivity was most rapid

in RW held at 20 C, it took about 10 days for a 99.0% reduction in the plaque titer of the virus. These findings, therefore, indicate that rotaviruses can survive for several days in raw and treated river water thus making recreational and potable waters potential vehicles for the transmission of rotavirus infections. (Author's abstract)
W85-06137

COMETABOLISM OF LOW CONCENTRATIONS OF PROPACHLOR, ALACHLOR, AND CYCLOATE IN SEWAGE AND LAKE WATER,
Cornell Univ., Ithaca, NY. Lab. of Soil Microbiology.
N. J. Novick, and M. Alexander.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 737-743, April, 1985. 6 Fig, 4 Tab, 25 Ref.

Descriptors: *Metabolism, *Propachlor, *Alachlor, *Cycloate, *Wastewater, *Lakes, *Pesticides, Mineralization, Fate of pollutants, Microorganisms.

Low concentrations of propachlor (2-chloro-N-isopropylacetanilide) and alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide) were not mineralized, cycloate (S-ethyl-N-ethylthiocyclohexanecarbamate) was slowly or not mineralized, and aniline and cyclohexylamine were readily mineralized in sewage and lake water. Propachlor, alachlor, and cycloate were extensively metabolized, but the products were organic. Little conversion of propachlor and alachlor was evident in sterilized sewage or lake water. The cometabolism of propachlor was essentially linear with time in lake water and was well fit by zero-order kinetics in short periods and by first-order kinetics in longer periods in sewage. The rate of cometabolism in sewage was directly proportional top propachlor concentration at levels from 63 pg/ml to more than 100 ng/ml. Glucose but not aniline increased the yield of products formed during propachlor cometabolism in sewage. No microorganism able to use propachlor as a sole source of carbon and energy was isolated, but bacteria isolated from sewage and lake water metabolized this chemical. During the metabolism of this herbicide by two of the bacteria, none of the carbon was assimilated. Our data indicate that cometabolism of these pesticides takes place at concentrations of synthetic compounds that commonly occur in natural waters. (Author's abstract)
W85-06138

VIRUS PERSISTENCE IN GROUNDWATER,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
M. V. Yates, C. P. Gerba, and L. M. Kelley.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 778-781, April, 1985. 3 Tab, 19 Ref.

Descriptors: *Viruses, *Groundwater pollution, *Fate of pollutants, Infection, Microorganisms, Poliovirus, Echovirus, Coliphage, Source of pollutants, Physicochemical properties.

More than 50% of the outbreaks of waterborne disease in the United States are due to the consumption of contaminated groundwater. An estimated 65% of the cases in these outbreaks are caused by enteric viruses. Little, however, is known about the persistence of viruses in groundwater. The purpose of this study was to determine whether measurable chemical and physical factors correlate with virus survival in groundwater. Groundwater samples were obtained from 11 sites throughout the United States. Water temperature was measured at the time of collection. Several physical and chemical characteristics, including pH, nitrates, turbidity, and hardness, were determined for each sample. Separate water samples were inoculated with each of three viruses (poliovirus 1, echovirus 1, and MS-2 coliphage) and incubated at the in situ groundwater temperature; selected samples were also incubated at other temperatures. Assays were performed at predetermined intervals over a 30-day period to determine the number of infective viruses remaining. Multiple regression analysis revealed that temperature was the only variable significantly correlated with the decay rates of all three viruses. No significant differences were found among the decay rates of the three viruses, an indication that MS-2 coliphage might be used as a model of animal virus survival in groundwater. (Author's abstract)
W85-06140

COPPER-BINDING CHARACTERISTICS OF EXOPOLYMERS FROM A FRESHWATER-SEDIMENT BACTERIUM,
California State Univ., Long Beach. Dept. of Microbiology.
For primary bibliographic entry see Field 2H.
W85-06144

BIODEGRADATION OF (14C)PHENOL IN SECONDARY SEWAGE AND LANDFILL LEACHATE MEASURED BY DOUBLE-VIAL RADIORESPIROMETRY,
Oklahoma Univ., Norman, Environmental and Ground Water Inst.
G. M. Deeley, P. Skierkowski, and J. M. Robertson.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 867-869, April, 1985. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Phenol, *Isotope studies, *Biodegradation, *Leachate, *Radiorespirometry, *Wastewater, Microorganisms, Aquifers, Fate of pollutants.

Double-vial radiorespirometry was used to estimate the biodegradation rates of C-14-labeled phenol in a landfill leachate and a secondary treated domestic wastewater. Rates were found to be comparable for each material at each of the three concentrations tested. Sewage microorganisms immediately began biodegrading the (C-14)phenol; landfill leachate microorganisms required a lag period before maximum biodegradation of the (C-14)phenol. The apparent rate of (C-14)phenol biodegradation was 2.4 times faster in the sewage than in the landfill leachate. Double-vial radiorespirometry was shown to be an effective method for screening biodegradation rates in aquifers. (Author's abstract)
W85-06145

GROUNDWATER CONTAMINATION BY VOLATILE HALOGENATED ALKANES: ABIOTIC FORMATION OF VOLATILE SULFUR COMPOUNDS UNDER ANAEROBIC CONDITIONS,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
R. P. Schwarzenbach, W. Giger, C. Schaffner, and O. Wanner.
Environmental Science and Technology, Vol. 19, No. 4, p 322-327, April, 1985. 5 Fig, 5 Tab, 29 Ref.

Descriptors: *Groundwater pollution, *Halogenated alkenes, *Halogenated hydrocarbons, *Hydrogen sulfide, *Chemical reactions, Fate of pollutants, Sulfides.

Under highly reducing conditions in the presence of hydrogen sulfide in groundwater, certain volatile bromo- and chloroalkanes may undergo second-order nucleophilic substitution reactions leading to the formation of persistant and hazardous sulfur-containing compounds, including dialkyl sulfides. The data originate from the investigation of groundwater contamination caused by a leaking wastewater tank of a chemical plant. Rate constants determined in the laboratory indicate that these nucleophilic substitution reactions may compete with hydrolysis, even at the low hydrogen sulfide concentrations typically encountered in the aquatic environment. The majority of environmentally important halogenated hydrocarbons have aromatic, vinylic, or geminal-polyhalogenated structures and are therefore less susceptible to nucleophilic substitution reactions. (Collier-IVI)
W85-06148

REACTION OF DISSOLVED CHLORINE WITH SURFICIAL SEDIMENT: OXIDANT DEMAND AND PRODUCTION OF TRIHALOMETHANES,
Maryland Univ., Solomons. Chesapeake Biological Lab.
A. D. Uhler, and J. C. Means.
Environmental Science and Technology, Vol. 19, No. 4, p 340-344, April, 1985. 8 Fig, 4 Tab, 24 Ref.

Descriptors: *Chlorine, *Sediments, *Trihalomethanes, *Chemical reactions, Fate of pollutants, Salinity, Organic carbon.

Reactions between dissolved HOCl and surficial sediments from the Potomac River, MD, are reported. All sediments samples showed a tendency to react with HOCl under a range of pH (5-10) and salinity (0-30 mg/L) conditions. At pH 7.0 and 0% salinity, the average HOCl demand was approximately 0.07 mol of HOCl/mol of adsorbed organic carbon. The only purgeable organic compounds produced by the chlorination of these sediments were trihalomethanes. The speciation and yield of trihalomethanes were found to be a sensitive function of salinity. Along the salinity gradient 0-30% at pH 7.0, trihalomethane production reached a maximum at about 5% salinity and then rapidly fell off with increasing salinity. Increasing salinity alters the reactivity of adsorbed organic matter, resulting in a less reactive material at high salinities. (Author's abstract)
W85-06149

CONTEMPORARY LAKE TRANSPORT PROCESSES DETERMINED FROM SEDIMENTARY RECORDS OF COPPER MINING ACTIVITY,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2J.
W85-06150

BEHAVIOR OF RADIONUCLIDES IN RIVERS AS DEMONSTRATED IN THE CASE OF CO 60 FROM THE NUCLEAR POWER STATION WURGASSEN/WESER (UBER DAS VERHALTEN VON RADIONUKLIDEN IN FLIESSGEWASSERN AM BEISPIEL VON CO 60 AUS DEM KERNKRAFTWERK WURGASSEN/WESER),
Bundesanstalt fuer Gewaesserkunde, Coblenz (Germany, F.R.).
H. Mundschenk.
Deutsche Gewasserkundliche Mitteilungen, Vol. 28, No. 5/6, p 134-145, December, 1984. 16 Fig, 2 Tab, 26 Ref.

Descriptors: *Radioactive wastes, *Nuclear powerplants, *Fate of pollutants, *Dredging, *Weser, *Germany (Federal Republic), Cobalt radioisotopes, Suspended solids, Sedimentation, Spoil banks, Land disposal, Radioisotopes.

Radionuclides released from the nuclear power plant Wurgassen (KWW) can be detected in suspended matter and sediment in the river Weser (Federal Republic of Germany) even at large distances from the point of discharge using Co-60 as a tracer. The contamination of sediment is increasing downstream with increasing distance from the emitter. The main fraction of Co-60 (> or = 57%) is adsorbed and transported by suspended matter into the estuary. A smaller fraction (< or = 43%) accumulated in suspended matter contaminates the sediment phase by sedimentation along the watercourse. The part dissolved in water is estimated to be less than 10%. In order to maintain the feasibility of shipping traffic, sediment have to be continuously removed by dredging, especially in the lower part of the river. Because of the contamination of Weser river sediments, workers are exposed to radiation by handling and depositing the contaminated material on land sites. The potential external radiation exposure derived from values measured between 1979 to 1983 amounts to 0.5 mrem/1000 h in the case of Co 60. The dose resulting from all radionuclides released by KWW is estimated to be approximately 1 mrem/1000 h, far below the whole body dose limits in the German Radiological Protection Ordinance (30 mrem/a). This area must be considered as a so-called critical impact area according to sect. 45 of the German Radiolog-

ical Protection Ordinance, especially, if sediment is dredged and deposited on land as is the case of the lower part of the river. (Moore-IVI)
W85-06155

ASBESTOS IN LAKE AND RESERVOIR WATERS OF STATEN ISLAND, NEW YORK: SOURCE, CONCENTRATION, MINERALOGY, AND SIZE DISTRIBUTION,
Rutgers - The State Univ., Newark, NJ. Dept. of Geology.
G. P. Maresca, J. H. Puffer, and M. Germine.
Environmental Geology and Water Science, Vol. 6, No. 4, p 201-210, 1984. 4 Fig, 2 Tab, 63 Ref. Project A-067-NJ.

Descriptors: *Asbestos, *Water pollution sources, *Staten Island, *New York, Silver Lake Reservoir, Lakes, Reservoirs, Mineralogy, Serpentinite, Chrysotile.

In view of the hazards of asbestos exposure and the numerous occurrences of asbestos-bearing bedrock on Staten Island (New York), a study was undertaken to examine water supplies for influx of asbestos from bedrock sources. In the Silver Lake Reservoir in Staten Island, where chrysotile from serpentinite bedrock exposures is a potential source of contamination, chrysotile asbestos levels of 15 to 86 million fibers per liter (MFL) were measured, with an average of 53 MFL. Much lower levels (average 0.3 MFL) were observed in small lakes and ponds with clayey bottoms on the Staten Island Serpentinite. Silver Lake Reservoir is currently a part of the New York Parks and Recreation Department and its water is not used for drinking. Decisions pertaining to future uses of Silver Lake should clearly consider the high concentration of asbestos in the reservoir water. The potentially high degree of asbestos contamination from bedrock sources should also be considered in site selection for reservoirs on asbestos-bearing bedrock, particularly serpentinites. (Moore-IVI)
W85-06160

5C. Effects Of Pollution

SURVEY OF SODIUM DODECYL SULPHATE (SDS) RESISTANCE AND ALKYLSULPHATASE PRODUCTION IN BACTERIA FROM CLEAN AND POLLUTED RIVER SITES,
University Coll., Cardiff (Wales). Dept. of Biochemistry.
G. F. White, N. J. Russell, and M. J. Day.
Environmental Pollution, Vol. 37, No. 1, p 1-11, 1985. 2 Tab, 12 Ref.

Descriptors: *Sodium dodecyl sulfate, *Alkylsulfatase, *Bacteria, *Water pollution effects, Enzymes, Sulfates, Surfactants.

A survey of riverine bacteria showed that the ability to grow in the presence of the surfactant sodium dodecyl sulfate (SDS) was widespread but the proportion of SDS-resistant isolates was significantly greater at a polluted site, as compared with clean source water. Bacteria containing the alkylsulfatases that initiate SDS degradation were also widespread. The polluted site yielded significantly more alkylsulfatase-containing strains than the clean site, and this difference was due to a greater number of strains at the polluted site bearing constitutive rather than inducible enzymes. In addition, the incidence of strains containing multiple alkylsulfatases was much higher at the polluted than at the clean site. (Author's abstract)
W85-05848

EFFECTS OF COPPER ON THE COMPETITIVE INTERACTIONS OF TWO SPECIES OF CLADOCERA,
EG and G Bionomics, Wareham, MA.
G. A. LeBlanc.
Environmental Pollution, Vol. 37, No. 1, p 13-25, 1985. 6 Fig, 1 Tab, 26 Ref.

Descriptors: *Copper, *Cladocera, *Daphnia, *Toxicity, Crustaceans, Animal behavior, Water pollution effects.

The influence of copper on the competitive interactions between Daphnia magna and Daphnia pulex was assessed. Prior studies indicated that D. magna could develop tolerance to the toxic effects of copper whereas D. pulex could not. Although D. pulex is generally a superior competitor over D. magna, it was hypothesized that the presence of copper may lend competitive superiority to D. magna, thus ensuring its survival under this environmental condition. D. magna and D. pulex were cocultured during this study: (1) in the absence of exogenous copper; (2) after temporary exposure to a sublethal copper concentration (10 micro g/liter); (3) after temporary exposure to a copper concentration lethal to a portion of the exposed population (30 micro g/liter); and (4) after temporary exposure to successive treatments of 10 and 30 micro g/liter copper. D. pulex populations consistently exceeded D. magna populations when cocultured in the absence of copper or after temporary exposure to 10 micro g/liter copper. Exposure to 30 micro g/liter or sequential treatments of 10 and 30 micro g/liter copper severely reduced the initial population growth of D. pulex whereas D. magna were unaffected. Although the D. magna populations were dominant by day 14 under these conditions, they did not suppress growth of the D. pulex populations. D. pulex subsequently gained population dominance and inhibited further growth of the D. magna populations. The reduced size of the D. magna suggested that D. pulex was outcompeting D. magna for available food. This study, in conjunction with others, suggests that D. magna population growth is augmented by the presence of low levels of copper. In addition, the inhibiting effect of copper on D. pulex population growth relieves D. magna of the competitive inhibition experienced when these species are together. (Author's abstract)
W85-05849

EFFECTS OF TEMPERATURE, FEEDING AND ACRIDINE ON REPRODUCTION OF THE CALANOID COPEPOD, DIAPTOMUS CLAVIPES SCHACHT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. D. Cooney, and C. W. Gehrs.
Environmental Pollution, Vol. 37, No. 1, p 53-70, 1985. 3 Fig, 4 Tab, 28 Ref. Office of Health and Environmental Research, US DOE contract W-7405-eng-26.

Descriptors: *Toxicity, *Water temperature, *Acridine, *Copepods, *Reproduction, Water pollution effects, Azaarenes, Life cycles.

Chronic toxicity determinations (using changes in reproduction as an index of toxicant stress) were performed on adults of the freshwater calanoid copepod, Diaptomus clavipes, at temperatures of 16, 21 and 26 C. Adults were paired and then exposed for 15 days to five concentrations (0.32-3.2 mg/liter) of the azaarene, acridine, in a renewal system. Two control groups (methanol control and well water control) were also used. Four reproductive criteria (number of eggs per clutch, number of clutches per female per day, number of eggs per female per day and percentage egg hatch) were evaluated. Mean clutch size was significantly reduced in acridine-exposed animals only at 21 C. Rate of clutch production was a more sensitive indicator of acridine stress than clutch size in all temperatures tested. Rate of egg production yielded results similar to those for clutch size. Egg viability was not affected by either temperature or acridine concentration, with more than 84% of the eggs hatching in most cases. No reproduction occurred at the highest acridine concentration tested (3.2 mg/liter) at all three temperatures; copepods at the next highest acridine concentration (1.8 mg/liter) produced only 2.5% of the total 1127 clutches produced in all exposure conditions. (Author's abstract)
W85-05850

EFFECTS OF A SEWAGE LAGOON EFFLUENT ON THE WATER QUALITY OF THE RECEIVING STREAM,
Ife Univ. (Nigeria). Dept. of Microbiology.
N. Okoronkwo, and O. Odeyemi.
Environmental Pollution, Vol. 37, No. 1, p 71-86, 1985. 6 Fig, 1 Tab, 15 Ref.

Descriptors: *Wastewater lagoons, *Water pollution effects, *Ife-Ife, *Nigeria, *Bacteria, Coliforms, Hydrogen ion concentration, Wastewater pollution, Water pollution sources.

The water quality of an actively used small stream receiving the University of Ife (Ife-Ife, Nigeria) sewage lagoon effluent was assessed down to 10 km below the pollution source. Fecal coliforms, total coliforms and heterotrophic bacteria were enumerated and the pH and dissolved oxygen values determined. Fecal coliform numbers in the region of the stream used to irrigate vegetables and farm crops in the dry season ranged from 100,000 to 1,000,000/100 ml while populations as high as 100 to 10,000/100 ml were obtained in the parts of the stream used for various domestic activities. Total coliform density ranged from 1000 to 10,000,000/100 ml in the actively used zone of the receiving stream. Furthermore, the total heterotrophic bacterial population of the receiving stream was raised from 100,000 to 10 to the 8th power/ml after mixing with the lagoon effluent, and was only reduced to about 100,000/ml at 10 km downstream of the mixing point. The dissolved oxygen of the receiving stream dropped from 7.6 mg/liter to values less than 2 mg/liter on mixing with the effluent. The dissolved oxygen sag continued to 8 km downstream, after which detectable reaeration of the stream began. The various data strongly suggest that serious public health hazards could result from the use of this stream into which undisinfected sewage lagoon effluent is discharged. (Author's abstract)
W85-05851

UPTAKE OF DIQUAT BY FOUR AERO-AQUATIC HYPHOMYCETES,
Waterloo Univ. (Ontario). Dept. of Biology.
A. Fronda, and B. Kendrick.
Environmental Pollution, Vol. 37, No. 3, p 229-244, 1985. 4 Fig, 1 Tab, 23 Ref.

Descriptors: *Aquatic fungi, *Aquatic plants, *Diquat, *Herbicides, Water pollution effects, Pesticides, Fungi.

The effects of xenobiotics on fungi colonizing leaf-litter and the consequences for the organisms which eat them have not been studied previously. Cultures of pond-dwelling fungi were challenged with various levels of the aquatic herbicide, diquat dibromide. The fungi used belong to the aero-aquatic hyphomycetes group which produce 'bubble trap propagules' which entrap air and float. Growth of Helicoon elegans, Hormiactis ontariensis, and Beverwykella pulmonaria was shown to be strongly inhibited by diquat dibromide. Pseudoaergerita matsushimae was little affected by the herbicide in concentrations of up to 10 micro g/ml. The former three species absorbed diquat; extraction from P. matsushimae was unsuccessful. Preliminary feeding studies suggest that small invertebrates such as snails (Lymnaea sp.), when provided with a choice of mycelia of the four fungal species grown in media containing diquat, prefer to graze on P. matsushimae, rather than on any of the other three fungi investigated. Fungi such as P. matsushimae, which do not accumulate the pollutants inside their cells, and thus represent uncontaminated food sources for invertebrates, might be regarded as elements favorable to the reestablishment of homeostasis in the pond system following its contamination. (Collier-IVI)
W85-05852

CARDIO-RESPIRATORY RESPONSES OF RAINBOW TROUT DURING RECOVERY FROM ZINC TREATMENT,
Bristol Univ. (England). Research Unit for Comparative Animal Respiration.
G. M. Hughes, and L. Tort.
Environmental Pollution, Vol. 37, No. 3, p 255-266, 1985. 6 Fig, 21 Ref.

Descriptors: *Trout, *Fish physiology, *Zinc, *Water pollution effects, *Toxicology, Animal physiology, Respiration, Metals.

Rainbow trout Salmo gairdneri were subjected to zinc treatment (20 mg/liter for 120 min and 20 mg/liter for 150 min) during which ventilatory and coughing frequencies were recorded. A third group of untreated fish formed a control group. After treatment, the fish were transferred to zinc-free water for 30 min, after which they were placed in a closed circulation system for seven days. Mortality, ventilatory, and coughing frequencies were recorded; plotting the position of each ECG in a ventilatory cycle made it possible to calculate the percentage coupling and phase angle. The treated groups showed a similar mortality rate during the recovery period, reaching 50% mortality (with respect to controls) after 12 days; mortality was more common during the first days of recovery. 120 min-treated fish recover normal values for ventilation, ECG and coughing after 5-6 days, while a longer period is required following treatment for 150 min. Percentage coupling is higher only during the first day, no significant differences being observed from day 2. The phase angles are concentrated in the third quadrant in treated fishes. About 40% of the zinc entering a fish would be retained and the effects of zinc would remain. Zinc responsible for the main cardio-respiratory parameters, such as ventilation, coughing, and ECG, could be washed out during the first few days and recovery of zinc-damaged gill structure enables the fish to survive and recover normal values. Other impairments at an internal level could more easily disappear following transfer of the fish to zinc-free water and the consequent cessation of the continuous uptake of the metal. Additional protective mechanisms at a cellular or molecular level may also be involved. (Collier-IVI)
W85-05853

POLLUTION MONITORING USING THE NEMATODE/COPEPOD RATIO, A PRACTICAL APPLICATION,
Napier Coll., Edinburgh (Scotland). Dept. of Biological Sciences.
G. M. Shiells, and K. J. Anderson.
Marine Pollution Bulletin, Vol. 16, No. 2, p 62-68, February, 1985. 5 Fig, 4 Tab, 12 Ref.

Descriptors: *Pollution monitoring, *Nematodes, *Copepods, *Bioindicators, *Firth of Forth, *Scotland, Aquatic animals, Water pollution effects, Species composition, Benthos.

Results of a study of the influence of sewage pollution on the benthic ecology of the Firth of Forth coastline bordering the city of Edinburgh, Scotland, carried out during the period 1977-1981 included data on distribution of the nematode and harpacticoid copepod fauna. The practical application of the nematode/copepod ratio in a pollution monitoring study was investigated. Ratios from polluted sites were much higher than from a clean site, but there is considerable evidence which casts doubt on the credibility of the ratio as a tool to detect organic pollution. Nematodes and copepods exhibited differing degrees of contagion. Seasonal patterns of variation of the ratio were shown to vary geographically and at some sites the seasonal range was great. For the N/C ratio to be considered useful as an indicator of pollution, values would be expected to vary predictably along sewage contamination gradients; the ratio was shown to vary in an inconsistent manner along sewage pollution gradients in time and space. A possible improvement to the ratio would be to include interstitial forms in the calculation. (Collier-IVI)
W85-05860

EFFECTS OF THE BLACK RIVER (CAPE, SOUTH AFRICA) ON THE DISTRIBUTION AND SURVIVAL OF MARINE PSAMMOFAUNA,
Texas A and M Univ., College Station. Dept. of Veterinary Anatomy.
For primary bibliographic entry see Field 2L.
W85-05861

SEPARATION OF SOLUTE AND PARTICULATE VECTORS OF HEAVY METALS UPTAKE IN CONTROLLED SUSPENSION-FEEDING EXPERIMENTS WITH MACOMA BALTHICA,
Geological Survey, Menlo Park, CA.
R. W. Harvey, and S. N. Luoma.
Hydrobiologia, Vol. 121, No. 2, p 97-102, February, 1985. 3 Fig, 1 Tab, 11 Ref.

Descriptors: *Water pollution effects, *Clams, *Mollusks, *Heavy metals, Radioisotope studies, Bacteria, Suspended solids.

An easy-to-use filter-chamber device was used to separate solute metal uptake from uptake of metals associated with suspended bacteria, in radioisotope labelling experiments with the estuarine clam, Macoma balthica. Solute uptake contributed a majority of the 14-day total body burdens of Zn-65 and Cd-109, whereas Co-57 uptake largely resulted from ingestion of isotope-laden bacteria. In contrast to those for Cd-109 and Zn-65, Co-57 tissue distributions at 3 weeks differed significantly ($p < 0.05$) between feeding and non-feeding clams (housed within filter chambers). The solute vector must be accounted for in any investigations of food source contribution to heavy metal accumulation in benthic invertebrates. The importance of solute uptake depends, in part, upon the particular metal. (Collier-IVI)
W85-05863

GROWTH RESPONSE OF ANACYSTIS NIDULANS TO SODIUM AND PHOSPHATE AVAILABILITY,
State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.
J. C. Makarewicz, and D. A. McKellar.
Hydrobiologia, Vol. 121, No. 2, p 129-137, February, 1985. 6 Fig, 1 Tab, 47 Ref.

Descriptors: *Chlorophyta, *Algae, *Sodium, *Phosphates, *Nutrients, Water pollution effects, Potassium.

Indirect evidence has suggested that blue-green algal populations may be enhanced by increasing sodium concentrations of allochthonous origin. The growth response of Anacystis nidulans to sodium and phosphate was studied in batch cultures under controlled laboratory conditions. Sodium (range = 0-10 mg/l) significantly enhanced growth, most notably, after sodium and phosphate starvation. The magnitude of the increase in growth was dependent on the initial cell density, external concentrations of phosphate, sodium, and potassium, and the nutritional status of the algal inoculum. With a lower potassium concentration, the growth response to sodium was smaller. This suggests that the potassium requirement of the algae must be met for maximum effect of increasing sodium concentrations. Sodium may influence phosphate uptake and storage and growth. In the green alga Chlamydomona, no sodium stimulation of growth occurred as was observed with A. nidulans, which suggests that increased sodium levels in lakes would favor at least a non-nitrogen fixing blue-green algae. The increase in ambient sodium levels in many lakes may provide a competitive advantage to some blue-green algae. (Collier-IVI)
W85-05866

CHANGES IN OXYGEN CONSUMPTION AND NITROGEN METABOLISM IN THE DRAGONFLY SOMATOCHLORA CINGULATA EXPOSED TO ALUMINUM IN ACID WATERS,
Massachusetts Univ., Amherst. Dept. of Environmental Sciences.
M. Correa, R. A. Coler, and C.-M. Yin.
Hydrobiologia, Vol. 121, No. 2, p 151-156, February, 1985. 5 Tab, 34 Ref.

Descriptors: *Toxicity, *Aluminum, *Hydrogen ion concentration, *Dragonflies, *Acidic water, Animal physiology, Metabolism, Water pollution effects.

The impact of low pH and sublethal aluminum concentrations on respiration rate and ammonia accumulation and excretion was studied in different nymphal stages of the dragonfly Somatochlora cingulata. Oxygen consumption, ammonia excretion and changes in O:N ratios were measured in four nymphal growth stages, relative to aluminum concentrations and low pH. Very significant differences were found between controls and experimental animals exposed to low pH and to sublethal aluminum concentrations plus low pH. Sublethal aluminum concentrations were as toxic as low pH alone. Aluminum did not provoke a significant change in the respiratory rate compared to low pH alone. A differential reduction in respiration and ammonia excretion rates resulted in an increase in O:N ratios for all nymphal stages. The earlier stages, however, were the most sensitive. The ratios obtained were indicative of a decreased dependence on protein reserves and increased utilization of carbohydrates or lipid reserves. Also observed was an increase in the hemolymph pH and glutamate levels with a concomitant accumulation of tissue ammonia. S. cingulata partially compensates for the disruption of its excretory processes, induced by exposures by Al and low pH, by reducing the quantity of accumulated metabolites; this is accomplished through depressed oxygen consumption, restricted utilization of protein as fuel, and shifting intermediate metabolism toward the synthesis of glutamate. (Collier-IVI)
W85-05867

CHIRONOMIDAE IN A PENNINE STREAM SYSTEM RECEIVING MINE DRAINAGE AND ORGANIC ENRICHMENT,
Freshwater Biological Association, Wareham (England). River Lab.
P. D. Armitage, and J. H. Blackburn.
Hydrobiologia, Vol. 121, No. 2, p 165-172, February, 1985. 2 Fig, 3 Tab, 23 Ref.

Descriptors: *Midges, *Acid mine drainage, *Water pollution effects, *Species composition, *Organic wastes, *River Nent, *England, Species diversity, Benthos, Biomonitoring, Bioindicators, Zinc, Metals, Alkaline water.

A survey was made of Chironomidae found at 17 sites in the River Nent of northern England which receives heavy metal inputs and organic enrichment. In its passage from source to junction with the S. Tyne, a distance of about 10 km, it receives zinc-rich water from a number of old mine levels together with acidic mine-drainage water and organic enrichment from domestic and agricultural sources. Sites with zinc concentrations > 2.00 mg/l supported fewer species than did sites with concentrations of zinc < 0.36 mg/l. Sites low down on the system with high total alkalinities supported low numbers of chironomids. Cluster analyses showed that Chironomidae alone could be used to differentiate between sites with varying degress of pollution in the same way as analyses using total benthos but in which Chironomids were identified only to sub-family level. The family Chironomidae contains much useful information which is masked unless identifications are made to species level. (Collier-IVI)
W85-05868

EFFECTS OF CADMIUM IONS ON THE ULTRASTRUCTURE OF THE GILL CELLS OF THE BROWN SHRIMP CRANGON CRANGON (L.) (DECAPODA, CARIDEA),
Institute of Oceanographic and Fisheries Research, Athens (Greece).
E. Papathanassiou.
Crustaceana, Vol. 48, No. 1, p 6-17, January, 1985. 5 Fig, 1 Tab, 20 Ref.

Descriptors: *Cadmium, *Toxicity, *Water pollution effects, *Shrimp, Crustaceans, Water pollution effects.

The toxic effects of cadmium on the ultrastructure of the gill cells of the brown shrimp were studied and related to functional differences in the organelles. The gill lamellae in C. crangon consists of an outer cuticle beneath which are the epithelial cells and a central hemocoele. After exposure to 50 ppm cadmium for 20 hr there were fewer organelles

present in the cells than in cells from untreated specimens, with more pronounced effect on the mitochondria. The nucleus, although still large in relation to the cell, had its outer membrane disrupted in places. The mitochondria were swollen and contained fewer cristae than in controls. There were fewer ribosomes and the invaginations of the apical plasma membrane were smaller. Microtubules were present as long bundles, randomly orientated and there were larger numbers of vesicles. The number of organelles present in the epithelial cells of the gill lamellae was reduced when specimens of C. crangon were exposed to 25 ppm of cadmium ions. After 20 hr exposure to 5 ppm cadmium there were fewer organelles present in the epithelial cells. The mitochondria were sausage shaped or spherical and fewer than in untreated controls. They possessed fewer disorientated cristae, which were partially degenerated. There was swollen endoplasmic reticulum present near the nucleus, often in contact with the outer membrane of the nuclear envelope. There were fewer free ribosomes, fewer invaginations of the apical plasma membrane, but more vesicles than in untreated specimens. (Baker-IVI)
W85-05875

CADMIUM ACCUMULATION BY THE BLUE CRAB, CALLINECTES SAPIDUS: INVOLVEMENT OF HEMOCYANIN AND CHARACTERIZATION OF CADMIUM-BINDING PROTEINS,
Duke Univ., Beaufort, NC. Marine Lab.
M. Brouwer, and T. Brouwer-Hoexum.
Marine Environmental Research, Vol. 14, No. 1-4, p 71-88, 1984. 12 Fig, 1 Tab, 26 Ref. NOAA grant NA80-RA-D-00063.

Descriptors: *Cadmium, *Crabs, *Hemocyanin, *Proteins, *Toxicity, Animal physiology, Gills, Heavy metals, Water pollution effects, Trace metals.

The accumulation of cadmium from seawater by the blue crab, Callinectes sapidus, was studied as a function of metal concentration and exposure time, with special emphasis on cadmium-binding proteins. Cadmium was found, in decreasing order of magnitude, in gills, digestive gland and hemolymph. When exposed to 0.5 ppm cadmium for 2-24 h, virtually all of the cadmium in the cytosolic fraction of the gill was associated with a low molecular weight (LMW) cadmium-binding protein (MW 8000). However, after 48 h of exposure only 50% of the cadmium in the cytosol was bound to this protein. The rest was found to be associated with proteins of a molecular weight of 300,000 and 60,000. This pattern of cadmium distribution did not change over a 12-day depuration period. Similar results were obtained upon exposure to 0.1 ppm cadmium. The pattern of cadmium accumulation in the cytosolic fraction of the digestive gland was in marked contrast to that observed for the gill. Initially, the cadmium was distributed over three low molecular weight fractions. During depuration the distribution of cadmium changed and all of the metal became bound to a low molecular weight protein (MW 9000). The cadmium concentrations in the gill and digestive gland remained essentially constant during depuration (12 days). The LMW cadmium-binding proteins were purified by a combination of gelpermeation and ion-exchange chromatography. Their molecular weight, spectral properties and amino acid composition are characteristic of the vertebrate metallothioneins. During exposure to cadmium the metal rapidly appeared in the hemolymph, mainly associated with hemocyanin. During depuration cadmium was transferred from the hemolymph to the digestive gland, demonstrating that hemocyanin acts as a carrier in trace metal transport. (Author's abstract)
W85-05881

ZINC AND CADMIUM METABOLISM IN EUGLENA GRACILIS: METAL DISTRIBUTION IN NORMAL AND ZINC-DEFICIENT CELLS,
Wisconsin Univ.-Milwaukee. Dept. of Chemistry.
D. J. Gingrich, D. H. Petering, and C. F. Shaw, III.
Marine Environmental Research, Vol. 14, No. 1-4, p 89-102, 1984. 4 Fig, 1 Tab, 20 Ref.

Descriptors: *Euglena, *Algae, *Cadmium, *Zinc, *Cadmium, *Metals, Plant physiology, Toxicity, Water pollution effects, Proteins, Physiology.

The effect of cadmium (5 micro g/ml) on the growth of Euglena gracilis is moderated by the addition of supplemental zinc levels above the normal 1 micro g/ml level found in the growth medium. Gel chromatography reveals that the majority (ca. 85%) of cytosolic cadmium is localized in a cadmium-binding protein (CdBP). The CdBP appears to elute in a position slightly lower in molecular weight than mammalian metallothionein, contains, thiol, and upon ion-exchange chromatography elutes in multiple peaks at ionic strengths greater than mammalian metallotioneins. The remaining cadmium is associated with high molecular weight components. Cytosolic zinc is found primarily (> 80%) in a low molecular weight peak distinct from cadmium, with the remainder as high molecular weight species. As the cells become zinc-deficient and cease proliferation, zinc is lost from the low molecular weight peak while, based on cytosolic protein, the zinc content of the high molecular weight peak remains essentially constant. (Author's abstract)
W85-05882

CELLULAR RESPONSES OF MOLLUSCAN TISSUES TO ENVIRONMENTAL METALS,
Reading Univ. (England). Dept. of Zoology.
K. Simkiss, and A. Z. Mason.
Marine Environmental Research, Vol. 14, No. 1-4, p 103-118, 1984. 6 Fig, 2 Tab, 16 Ref. Natural Environmental Research Council grant GR3/3063A.

Descriptors: *Heavy metals, *Animal physiology, *Mollusks, *Water pollution effects Toxicity, Bioindicators.

The use of marine organisms as monitors of pollution assumes that the processes involved in sequestration provide a response which is proportional to the concentration of the pollutant in the environment. This assumption is considered in relation to the known cellular properties of the systems involved. Studies on the kinetics of uptake of certain metals in estuarine conditions have included the possibility that they can occur in non-polar, lipid-soluble forms which may penetrate cell membranes very rapidly. Uptake of these metals is governed by first-order kinetics and that many of the assumptions undertaken during biological monitoring programs are, in fact, valid as a first approximation. Many heavy metals of interest to environmentalists are retained within the tissues by reactive ligands. These may be inducible, metabolized and excreted, and it is the 'turnover' and availability of these ligands which may ultimately determine the final concentration of the metal in the animal. Models and experimental studies of these activities indicate that the ligands are either non-specific in nature and capable of binding a wide variety of metals or are very specific for particular metals. The former ligands may contribute to a general system of detoxification while the latter appear to be integrated into precise metabolic pathways. (Author's abstract)
W85-05883

CADMIUM-BINDING PROTEINS IN THE BLUE CRAB, CALLINECTES SAPIDUS: LABORATORY - FIELD COMPARISON,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
D. W. Engel, and M. Brouwer.
Marine Environmental Research, Vol. 14, No. 1-4, p 139-151, 1984. 6 Fig, 1 Tab, 12 Ref.

Descriptors: *Cadmium, *Crabs, *Proteins, *Heavy metals, *Water pollution effects, Animal physiology, Copper, Zinc, Nickel, Metals, Crustaceans, Toxicity.

The blue crab, Callinectes sapidus, is distributed along the east coast of the United States from Cape Cod, Mass., through the Gulf of Mexico, including both relatively unpolluted coastal areas and estuaries contaminated with trace metals. Cadmium is of particular concern because it is concentrated in the digestive glands of blue crabs and can be passed on to consumer organisms. Tissue concentrations and partitioning of trace metals from crabs exposed in the laboratory to 100 ppb dissolved cadmium for 40 days were compared with blue crabs collected from two locatons on the Hudson River, NY, Foundry Cove and Haverstraw Bay, both of which have elevated trace metal levels relative to estuarine areas near Beaufort, NC. Crab digestive glands, gills and muscle were removed and analyzed for total cadmium, copper, zinc, and nickel concentrations using acid digestion and atomic absorption spectrophotometry, and metal-binding (metallothionein-like) proteins were determined by gel-filtration chromatography. In crabs exposed to cadmium in the laboratory, the cytosolic partitioning was similar to previous investigations at our laboratory where higher levels of cadmium (100 ppb) and shorter exposure times (14 days) were used. The similarity in cadmium partitioning from these two separate experiments indicates dose independence. In crabs from polluted environments the digestive glands contained the highest concentrations of trace metals. Chromatograms of the cytosol from the digestive glands and gills from both field and laboratory-exposed crabs showed similar distributions of cadmium, copper and zinc. The gills of both field and laboratory-exposed crabs had metal-binding proteins that contained mostly cadmium, and the digestive glands had metallothionein-like proteins that contained cadmium, copper and zinc. Estimated molecular weights for these proteins were similar to the metallothioneins found in other crustaceans and mammals. (Author's abstract)
W85-05884

METALLOTHIONEIN AND MERCURY TOLERANCE IN THE KILLIFISH, FUNDULUS HETEROCLITUS,
New Jersey Medical School, Newark. Dept. of Anatomy.
P. Weis.
Marine Environmental Research, Vol. 14, No. 1-4, p 153-166, 1984. 5 Fig, 2 Tab, 29 Ref.

Descriptors: *Metallothionein, *Mercury, *Killifish, *Fish, *Toxicity, Methylmercuric chloride, Mercuric chloride, Animal physiology, Fish physiology, Water pollution effects.

Synthesis of metallothionein (MT) as a possible mechanism by which Fundulus heteroclitus adapts to heavy metal pollution has been investigated in relation to responses to methylmercuric chloride (meHg) and $HgCl_2(Hg(2+))$ at different life stages. Clutches of embryos from unpolluted sites exhibit teratogenic responses to a standard dose of meHg or of $Hg(2+)$ which range from little or no effect (tolerant) to severely affected or almost complete inhibition of development (susceptible). At the time of hatching, untreated embryos from tolerant clutches had twice as much of a protein which co-migrates in SDS-PAGE gels with Fundulus MT as do those of susceptible clutches. This difference could be a mechanism for conveying tolerance to $Hg(2+)$ and also to meHg if demethylation occurs. However, eggs at the time of deposition had virtually no MT, suggesting that the protein is synthesized too late to provide tolerance in the early stages of development which are critical in the etiology of malformations. Treatment of embryos with non-teratogenic doses of either meHg or $Hg(2+)$ did not increase the amount of MT-like protein. This may indicate that the thionein gene is already fully active, and would also explain observations that $Hg(2+)$ pretreatment of embryos does not enhance tolerance to $Hg(2+)$ in the larval stage. MT, isolated from livers of $Hg(2+)$- or $Cu(2+)$-dosed or control adults, is associated with Cu and Zn but not with Hg, although it can bind $Hg(2+)$ in vitro. Fundulus, like other fish, methylates much (ca. 75%) of its Hg burden, and meHg is considered by some not to react with MT. Fundulus liver has its Hg burden distributed between homogenate sediment (25%), the cytosol (60%) and the remainder in lipid. The liver responds to $Hg(2+)$ treatment by increasing

lipid content. This may allow sequestration of some lipid-soluble meHg. Of the cytosolic Hg, most is associated with larger proteins and some (ca. 25%) is dialyzable. These data suggest that metallothionein is not a significant factor in Hg tolerance in Fundulus adults, and has a questionable role in embryonic and larval tolerance to Hg(2+) and none to the more toxic meHg. (Author's abstract)
W85-05885

RESPONSES OF THE MUSSEL MYTILUS EDULIS TO COPPER AND PHENANTHRENE: INTERACTIVE EFFECTS,
Institute for Marine Environmental Research, Plymouth (England).
M. N. Moore, J. Widdows, J. J. Cleary, R. K. Pipe, and P. N. Salkeld.
Marine Environmental Research, Vol. 14, No. 1-4, p 167-183, 1984. 9 Tab, 34 Ref.

Descriptors: *Mussels, *Copper, *Phenanthrene, *Organic compounds, *Toxicity, *Synergistic effects, Water pollution effects, Metals, Polycyclic hydrocarbons.

Most investigations of the responses of marine organisms to xenobiotics have connected on single contaminants and little is known of possible interactive effects of different classes of xenobiotics. As these latter seldom occur in environmental isolation, it is important to understand any interactions (synergistic or antagonistic) which may occur. This problem has been approached in the mussel Mytilus edulis by exposing estuarine mussels to copper (20 micro g/liter) and phenanthrene (100 micro g/liter) both individually and in combination, and measuring cytochemical subcellular and physiological responses after 3 days exposure and 3 days and 12 days recovery period. Results showed that mussels accumulated both xenobiotics during 3 days exposure. Depuration of copper was complete in 3 days recovery period, while loss of phenanthrene ranged from 30% to 70% of the concentration reached after 3 days exposure. There were no interactive effects on depuration. Both copper and phenanthrene reduced lysosomal hydrolase latency in digestive cells, and copper appeared to have a synergistic effect in preventing recovery of latency of lysosomal N-acetyl-beta-hexosaminidase during the recovery period. There was evidence, in the digestive cells, of an antagonistic effect of copper on stimulation of activity of the microsomal respiratory chain (measured as NADPH-neotetrazolium reductase) by phenanthrene. Stimulation of this system by phenanthrene persisted after 12 days recovery period. There was a synergistic interaction of copper and phenanthrene on elevation of oxygen consumption and ammonium excretion. Clearance rates and scope for growth (physiological condition) were depressed by copper but not by phenanthrene after 3 days exposure. These findings are discussed in terms of known efect of copper and phenanthrene and the interactions are considered in terms of environmental effects measurements. (Author's abstract)
W85-05886

INHIBITION OF ESSENTIAL AMINO ACID ABSORPTION IN MARINE FISHES BY MERCURY,
Rutgers - The State Univ., Piscataway, NJ. Nelson Biological Lab.
A. Farmanfarmaian, and R. Socci.
Marine Environmental Research, Vol. 14, No. 1-4, p 185-199, 1984. 1 Fig, 7 Tab, 57 Ref.

Descriptors: *Amino acids, *Mercury, *Heavy metals, *Fish physiology, *Water pollution effects, Toxicity, Intestines.

In polluted coastal waters marine fish can concentrate heavy metals in the intestine two or more orders of magnitude above those found in the water column and several-fold higher than the sediment level. These accumulations are primarily due to ingestion of contaminated food and drink. Relatively long residence time of gut content, low permeability coefficient of divalent cations through the lipid bilayers of membranes and profuse binding to the negative charge sites on the mucosal side of the gut, all combine to increase the concentration of heavy metals in the lumen. The effect of HgCl2 and CH3HgCl on the absorption of the essential amino acids, L-leucine, L-isoleucine, L-lysine and L-methioine, by the intestine of Fundulus and toadfish was measured in vitro and in vivo. At concentrations expected in the gut, HgCl2 can inhibit 20-80% of the leucine absorption. CH3HgCl is less potent in this respect. While the action of Hg(2+) appears to be limited to the luminal side, the more lipophilic CH3Hg(+) rapidly penetrates the epithelial cell layer and can inhibit the intracellular energy production needed for transport. The implications of these findings for growth and survival for marine fishes are discussed. (Author's abstract)
W85-05887

SERUM BIOCHEMICAL AND CELLULAR RESPONSES TO EXPERIMENTAL CUPRIC ION CHALLENGE IN MUSSELS,
Naval Ocean Systems Center, San Diego, CA.
G. V. Pickwell, and S. A. Steinert.
Marine Environmental Research, Vol. 14, No. 1-4, p 245-265, 1984. 6 Fig, 2 Tab, 20 Ref.

Descriptors: *Mussels, *Animal physiology, *Mollusks, *Copper, *Toxicity, Bioassays, Metals, Water pollution effects, Proteins.

Rapid and sensitive bioassay procedures were developed for laboratory and field applications based on hemolymph factors in animals such as the bay mussel, Mytilus edulis. Mussel hemolymph could be easily and repeatedly sampled from individual animals in sufficient amounts to allow analyses for lysozyme, proteolytic activity, total protein and hemocyte counts. In static tests there seemed to be graded responses indicating release of increasing amounts of the above factors into the hemolymph in roughly direct proportion to Cu(2+) concentration at lethal and sublethal levels which indicates increased lysosomal and cellular disruption as cupric ion exposure was increased or prolonged. At the same time, Cu(2+) concentrations in the mussel hemolymph increased up to an order of magnitude above ambient in the range of 26 to 267 ppb; this was evidence for the release of Cu-binding proteins into the mussel hemolymph. Simultaneously with the above events the serum granulocytes increased in numbers above control values by factors of 3 or 4 in response to copper challenge while macrophage counts, including controls, declined precipitously. (Author's abstract)
W85-05888

FIELD ASSESSMENT OF BIOCHEMICAL STRESS INDICES FOR THE SANDWORM NEANTHES VIRENS (SARS),
Battelle New England Marine Research Lab., Duxbury, MA.
R. S. Carr, and J. M. Neff.
Marine Environmental Research, Vol. 14, No. 1-4, p 267-279, 1984. 6 Tab, 33 Ref.

Descriptors: *Stress, *Sandworms, *Portland Harbor, *Maine, *Water pollution effects, Benthos, Sediment, Oil pollution, Animal physiology.

Certain biochemical stress responses have been observed in the laboratory for Neanthes virens subjected to various environmental and pollutant stressors. The purpose of the present study was to determine whether similar alterations in these biochemical parameters could be detected in a natural population of N. virens from a contaminated site as compared with animals from a nearby reference site. A site in Portland Harbor, Maine, adjacent to an oil storage facility with oil-contaminated sediments was selected as the experimental study area and the reference site was at Pine Point, approximately 15 miles south of Portland. Animals were collected from the two sites on consecutive days on a bimonthly basis at low tide within a day of the full moon for September 1981 through March 1982. Coelomic fluid samples were taken within 2 h after collection and the animals were then frozen in liquid nitrogen for transport back to the laboratory. Coelomic fluid samples were analyzed for glucose and the frozen tissues were analyzed for glycogen, lipid and free amino acid concentrations. Significant differences in these parameters were often observed between the two populations. The glycogen content of animals from the contaminated site was always less than that of animals from the reference site, whereas the lipid levels were always higher. Significant differences between the free amino acid composition of the animals from the two sites were also observed. Although distinct biochemical differences can be detected between these two populations, the considerable biological variation in these parameters may limit their usefulness for field monitoring investigations for this species. (Author's abstract)
W85-05889

USE OF THE AURELIA METAMORPHOSIS TEST SYSTEM TO DETECT SUBTLE EFFECTS OF SELECTED HYDROCARBONS AND PETROLEUM OIL,
Eastern Virginia Medical School, Norfolk, VA. Dept. of Pathology.
D. B. Spangenberg.
Marine Environmental Research, Vol. 14, No. 1-4, p 281-303, 1984. 5 Fig, 3 Tab, 38 Ref.

Descriptors: *Jelly fish, *Aurelia, *Hydrocarbons, *Bioassays, *Toxicity, Growth stages, Water pollution effects, Aniline, Anthracene, Benz-anthracene, Benzene, Benzo(a)pyrene, Biphenyl, Cresol, Napthalene, Perylene, Phenol, Pyrene.

The Aurelia Metamorphosis Test System was devised to use simple Aurelia polyps as indicator organisms for the detection of subtle effects of petroleum-related hydrocarbons and of Alaskan crude petroleum oil (ACPO) on developmental processes involved in strobilation initiation, differentiation of ephyrae, and genetic modification expressed through cloning. Compounds tested were ACPO, aniline, anthracene, benzanthracene, benzene, benzo(a)pyrene, biphenyl, cresol, naphthalene, perylene, phenol and pyrene. Gross morphology of the ephyrae (patterning, numbes and appearance of structures) statolith and nematocyst numbers, and pulsing behavior were recorded using the light microscope. Selected ephyrae with teratological malformations were studied with the scanning electron microscope and swimming behavior was observed visually. The variety of subtle developmental, behavioral and genetic effects due to marine hydrocarbons detected using the Aurelia Metamorphosis Test System demonstrated that this test system could be used as an early warning system to detect subtle effects of other marine pollutants. (Author's abstract)
W85-05890

EFFECTS OF TOXIC CHEMICALS ON MACROPHAGE PHAGOCYTOSIS IN TWO ESTUARINE FISHES,
Virginia Inst. of Marine Science, Gloucester Point.
B. A. Weeks, and J. E. Warinner.
Marine Environmental Research, Vol. 14, No. 1-4, p 327-335, 1984. 4 Fig, 12 Ref.

Descriptors: *Polyaromatic hydrocarbons, *Macrophages, *Phagocytosis, *Fish physiology, *Bioassays, *Elizabeth River, *Ware River, *Virginia, Water pollution effects, Toxicity, Hydrocarbons, Spot, Hogchoker.

The phagocytic efficiency of macrophages isolated from the kidney of spot, Leiostomus xanthurus, and hogchoker, Trinectes maculatus, was determined in fish captured from the Elizabeth River (Virginia). Fish were captured by trawl net from the reach of the Elizabeth River most contaminated with PAHs and from the Ware River. Macrophage phagocytosis was found to be markedly reduced in the Elizabeth River fish as compared to Ware River controls. The macrophages phagocytic activity of Elizabeth River fish returned to normal after the fish were held in clean water for several weeks. This indicates that the decreased phagocytic activity was related to exposure to Elizabeth River pollutants but may be reversible. If the results apply to a wide variety of species, this technique may make it possible to monitor fish

health on a broader scale and thereby assess the degree of environmental pollution. (Collier-IVI)
W85-05891

EFFECTS OF CONTAMINATED SEDIMENTS AND SEDIMENT-EXPOSED EFFLUENT WATER ON AN ESTUARINE FISH: ACUTE TOXICITY,
Virginia Inst. of Marine Science, Gloucester Point.
W. J. Hargis, Jr., M. H. Roberts, Jr., and D. E. Zwerner.
Marine Environmental Research, Vol. 14, No. 1-4, p 337-354, 1984. 7 Fig, 3 Tab, 21 Ref.

Descriptors: *Sediments, *Water pollution effects, *Elizabeth River, *Virginia, *Ware River, *Fish, Toxicity, Spot, Hydrocarbons, Polyaromatic hydrocarbons.

The Elizabeth River is Virginia's most heavily populated, industrialized and contaminated subestuary. Its sediments contain the residues of wastes discharged for several hundred years. Spot (Leiostomus xanthurus) were used in an examination of some of the effects of sediment from a particularly noxious location. The spot is a bottom-feeding sciaenid and naturally occurring spring-summer migrant of the river whose juveniles adapt readily to laboratory conditions. Spot from the Ware River, a nearby uncontaminated reference subestuary, were placed in two 38 liter (100 US gal), flow-through tanks (70 each). One tank contained Elizabeth River sediments contaminated with PAHs. The second tank contained uncontaminated sediment from the York River as a control. 13 spot each were placed in two aquaria that received the overflow from the sediment-containing tanks. Animals from the reference estuary were examined and processed to provide baseline information. Results obtained to date show the following: (1) spot experimentally exposed to contaminated sediment developed penetrating integumental lesions within 8 days after exposure began and later severe fin and gill erosion; (2) their hematocrits were significantly reduced and no weight gain occurred; (3) pancreatic and liver alterations were observed in some of the chemically stressed fish; (4) control fish exhibited no fin erosion or integumental lesions; (5) control fish showed no hematocrit or growth reduction; and (6) dead fish were first observed in the contaminated-sediment tank after 8 days while no control fish died. Clearly, one or more factors associated with Elizabeth River sediments and/or water closely associated with those sediments (probably the heavy concentrations of PAHs) are capable of causing serious injury, disease and death in experimental spot populations. (Author's abstract)
W85-05892

GILL FOULING AND PARASITISM IN THE ROCK CRAB, CANCER IRRORATUS SAY,
National Marine Fisheries Service, Oxford, MD. Northeast Fisheries Center.
T. K. Sawyer, E. J. Lewis, M. E. Galasso, and J. J. Ziskowski.
Marine Environmental Research, Vol. 14, No. 1-4, p 355-369, 1984. 1 Fig, 3 Tab, 32 Ref.

Descriptors: *Crabs, *Water pollution effects, *New York Bight, *Boothbay Harbor, *Maine, *Ocean dumping, *Gills, *Parasites, Sludge disposal, Waste disposal, Pathology.

Rock crabs, Cancer irroratus, were examined grossly and microscopically to estimate the influence of molting activity, geographical source and seabottom sediments on gill color, carapace color and tissue pathology. Collections were made from deepwater stations (20-55 m) in the Hudson Shelf Valley near dredge- and sewage-sludge disposal sites in the New York Bight apex, and from nearshore waters near Boothbay Harbor, Maine. Extensive gill blackening was noted in up to 30% of the crabs from the New York stations when all specimens were in the intermolt condition. Blackening was not noted in intermolt crabs collected in Maine. Carapace blackening was present in up to 79% of the New York crabs but absent in those from Maine. Severe blackening was attributed to direct contact of C. irroratus with blackened, highly organic sediments in the Hudson Shelf Valley. Fouling microorganisms on gill epicuticle included bacteria, diatoms, stalked ciliates, amoebae, flagellates and copepods. Bacteria, diatoms, amoebae and flagellates were common on crab gills from both locations. Ciliates and copepods counted in histological sections were considerably fewer in crabs from the New York stations than in those from Maine. Melanized nodules (hemocyte clumps) were present in gill tissue in up to 58% of the New York crabs and in up to 68% of Maine crabs. Unidentified microsporidans were found in up to 55% of the New York specimens and in less than 2% of those from Maine. Histological data accumulated since 1975 are summarized to provide a list of endoparasites, polychaete worms and barnacles observed in C. irroratus from the northeastern United States. Gill blackening, but not parasitism or microbial fouling, proved to be the best indicator for monitoring the effects of ocean dumping on the health of a benthic crustacean species. (Author's abstract)
W85-05893

HISTOPATHOLOGICAL CHANGES IN GRASS SHRIMP EXPOSED TO CHROMIUM, PENTACHLOROPHENOL AND DITHIOCARBAMATES,
University of West Florida, Pensacola. Dept. of Biology.
K. R. Rao, and D. G. Doughtie.
Marine Environmental Research, Vol. 14, No. 1-4, p 371-395, 1984. 42 Fig, 2 Tab, 37 Ref.

Descriptors: *Animal pathology, *Shrimp, *Chromium, *Pentachlorophenol, *Dithiocarbamate, *Gills, *Water pollution effects, Bioassays, Chlorinated hydrocarbons, Heavy metals, Metals, Toxicity, Animal physiology.

Histopathological/ultrastructural changes were monitored in various tissues of grass shrimp (Palaemonetes pugio) exposed to hexavalent chromium, pentachlorophenol (PCP) and two dithiocarbamate formulations: Aquatreat DNM-30 (15% sodium dimethyl dithiocarbamate plus 15% disodium ethylene bis-dithiocarbamate) and Busan-85 (50% potassium dimethyl dithiocarbamate). The pathological alterations induced by dithiocarbamates and PCP were most severe and first evident in the gills. Of the biocides tested, the dithiocarbamates caused the most extensive branchial damage - the so-called black gill syndrome, involving early melanization and eventual lamellar truncation. Hexavalent chromium, on the other hand, did not induce marked changes in the gills, but it caused invasive melanized cuticular lesions (particularly at the articulations of the periopods, pleopods and abdominal segments). Additionally, chromium caused apparent labyrinth hypoactivity in the antennal glands, whereas the dithiocarbamates seemed to induce labyrinth hyperactivity. Hepatopancreatic histopathology was more severe in shrimp exposed to chromium and PCP than in dithiocarbamate-exposed shrimp. The apparent mitotic activity in the hepatopancreas was increased in Aquatreat-exposed shrimp and suppressed in chromium-exposed shrimp; many mitotic figures in the latter case were abnormal. All four compounds caused varying degrees of midgut epithelial hypertrophy, cytoplasmic vacuolization and diminution of basal tubular endoplasmic reticulum, but only PCP caused widespread rupture, of midgut epithelial cell apices. Additional notable ultrastructural anomalies included: mitochondrial compartmentalization in PCP-exposed shrimp; mitochondrial fusion in dithiocarbamate-exposed shrimp; and unusual intranuclear inclusions in different tissues of chromium-exposed shrimp. These pathological changes point to differences in the mechanisms of pollutant toxicity and indicate their potential use in the biological monitoring of aquatic pollutants. (Author's abstract)
W85-05894

INTERSPECIES DIFFERENCES IN HEAVY METAL DETOXICATION IN OYSTERS,
Institute of Marine Biochemistry, Aberdeen (Scotland).
S. G. George, B. J. Pirie, J. M. Frazier, and J. D. Thomson.
Marine Environmental Research, Vol. 14, No. 1-4, p 462-464, 1984. 8 Ref.

Descriptors: *Heavy metals, *Detoxication, *Oysters, Water pollution effects, Cadmium, Zinc, Copper, Toxicity.

In an analytical electron microscopic study of the response of Ostrea edulis from a highly metalliferous environment to Cd exposure for 100 days, it was found that while the tissue Cu and Zn concentrations remained constant, there was a decrease in the numbers of metal-containing amoebocytes and that this is largely due to a reduction in numbers of the mixed Cu/Zn-containing cells rather than in the specific Cu- or Zn-containing cells. No specific Cd-containing blood cell or Cd-binding protein was found in the blood cells. Since only O. edulis contains the specific metal-containing cells, it is suggested that their function is one of metal detoxication and thus this may be an adaptive response to selection pressure of sustained Cu and Zn pollution for over 100 years. Comparisons with the results of other studies underscored the importance of simultaneous measurement of all interacting metals and of knowledge of the cellular localization of metals in order to secure a meaningful interpretation of data. (Baker-IVI)
W85-05896

INTRACELLULAR CONTROL OF CD CONCENTRATIONS IN MARINE MUSSELS,
Institute of Marine Biochemistry, Aberdeen (Scotland).
S. G. George.
Marine Environmental Research, Vol. 14, No. 1-4, p 465-468, 1984. 17 Ref.

Descriptors: *Mussels, *Cadmium, Heavy metals, Water pollution effects, Absorption, Isotope studies, Cadmium radioisotopes, Ligands.

Artificial liposomes containing Cd-109 were synthesized and Cd exchange measured in the presence of various intracellular complexing ligands. While there was measurable exchange of Cd in the absence of ligand, this was 4-fold faster than for Na and exchange was faster in the presence of glutathione or thionein. The data found were consistent with control of intracellular Cd concentrations being mediated by synthesis of an as yet unknown intracellular complexing ligand, or ligands, which also mediate uptake and initial detoxication, the synthesis of metallothionein and its turnover in the cell, the sequestration of metal by the tertiary lysosomes and excretion of these lysosomes. Since all these systesms are able to bind Cd, Cu and Zn, their metabolism is clearly interrelated and metabolic studies must involve simultaneous determination of all these metals. (Baker-IVI)
W85-05897

ALTERATIONS IN TISSUE WATER BALANCE AND ADENYLATES OF BLUEGILL (LEPOMIS MACROCHIRUS) EXPOSED TO COPPER,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. G. Heath.
Marine Environmental Research, Vol. 14, No. 1-4, p 483-485, 1984. 6 Fig.

Descriptors: *Water pollution effects, *Tissue water balance, *Adenylates, *Bluegill, *Copper, Adenosine triphosphate, Mitochondria, Fish, Heavy metals, Enzymes, Toxicity.

Use of tissue adenylate concentrations as indicators of environmental copper stress in freshwater fish was investigated. Bluegill were exposed in a flow through system to copper (2.0 mg/liter unfiltered; 1.2l mg/liter filtered through 40 U filter) for 24, 48, 72 and 96 hr at 24 C. Tissue water content of liver increased 4.8% by 24 hr and in muscle 4.6% by 48 hr. The increased water content may be due largely to inhibition of Na- or K-activated ATPase in the gill tissue leading to osmoregulatory dysfunction. Copper exposed fish exhibited significant decreases in white muscle ATP, ADP, total adenylates and energy charge by 48 hr. The changes in ATP are due to some combination of increased

tissue water content, damage to mitochondria, and copper inhibition of cellular enzymes. At the concentration of copper used here, tissue hypoxia did not occur. (Baker-IVI)
W85-05898

HISTOPATHOLOGY OF MERCENARIA MERCENARIA AS AN INDICATOR OF POLLUTANT STRESS,
Delaware Univ., Newark. School of Life and Health Sciences.
M. R. Tripp, C. R. Fries, M. A. Craven, C. E. Grier, and C. E. Gates.
Marine Environmental Research, Vol. 14, No. 1-4, p 521-524, 1984. 2 Fig. NSF Grant OCE-77-24037.

Descriptors: *Water pollution effects, *Indicator organisms, *Clams, Organic compounds, Benzo(a)pyrene, Hexachlorobenzene, Pentachlorophenol, Enzymes, Toxicity, Hydrocarbons, Chlorinated hydrocarbons.

Morphological and biochemical parameters of Mercenaria mercenaria were evaluated for cyclic variations and to determine whether they were affected by chemical stressors. Test chemicals included benzo(a)pyrene (BAP), hexachlorobenzene (HCB) and pentachlorophenol (PCP). Tubule dimensions and digestive cell size changed slightly in HCB- and PCP-injected clams, but there was no change in BAP-injected clams. Lysosomal enzyme content varied irregularly. beta-Glucuronidase values were decreased in BAP-injected animals just after injection but returned to normal within a few days; all chemical-injected animals had higher than normal values by day 18. Acid phosphatase values were depressed at day 2, rebounded sharply to above control values by day 4 and gradually decreased towards normal thereafter. Clams held for 6 months in seawater plus test chemicals did not show significant changes in tubule width or length, lumen width or cell height. HCB and BAP both decreased cell width while PCP decreased both lumen length and cell width. Clams injected with BAP, HCB, or PCP had some significant changes in tubule or cell dimensions. They also showed altered concentrations of lysosomal enzymes but not massive lysis of digestive tubule cells. These data suggest that BAP had no significant effect on M. mercenaria while HCB and PCP may have mildly toxic effects on the digestive gland. (Baker-IVI)
W85-05899

ENVIRONMENTAL IMPLICATIONS OF NEOPLASIA IN GREAT LAKES FISH,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Experimental Biology.
J. J. Black.
Marine Environmental Research, Vol. 14, No. 1-4, p 529-534, 1984. 1 Tab, 17 Ref.

Descriptors: *Great Lakes, *Fish, *Water pollution effects, *Neoplasia, Carcinogens, Organic compounds, Aromatic hydrocarbons, Liver, Skin, Bullheads, Polycyclic aromatic hydrocarbons.

The Great Lakes constitute the preeminent freshwater resource of North American and despite numerous point source and non-point source related pollution problems, they are major sources of sport and commercial fisheries of a diverse range of species. Brown bullheads, when exposed by skin painting to an organic solvent extract derived from a heavily polluted river sediment contaminated with a complex mixture of polycyclic aromatic hydrocarbons underwent a series of localized skin changes which progressed to neoplasia. Sensitivity to liver carcinogens present in the sediments was also indicated. Further studies will be required to determine the precise etiology of neoplasms found in Great Lakes fish populations. (Baker-IVI)
W85-05900

ENVIRONMENTAL HEALTH INVESTIGATION OF COPPER INTOXICATION FROM A PUBLIC WATER SUPPLY,
Vermont State Dept. of Health, Burlington. Div. of Environmental Health.
For primary bibliographic entry see Field 5F.
W85-05913

OFF-SITE COSTS OF SOIL EROSION,
Conservation Foundation, Washington, DC.
E. H. Clark, II.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 19-22, January-February, 1985. 1 Fig, 2 Tab, 20 Ref.

Descriptors: *Soil erosion, *Economic aspects, *Off-site costs, Soil loss, Sediments, Nutrients, Croplands, Salinity, Lakes, Streams.

Instream damages include biological impacts, recreational impacts, water storage damages, and navigation. Off-stream effects include flood damages, water treatment impacts, and water quality effects. Erosion-related pollutants are estimated to have had a net damage cost of $3.2 billion to $13.0 billion in 1980 with the single-value estimate being $6.0 billion per year. Cropland's share is $2.2 billion per year. Many of these costs, for instance, salinity damage to household and industrial water using equipment, are not directly related to erosion. They could continue even if erosion were stopped. The estimated damage directly related to sediment is $3.0 billion to $3.5 billion for all sources, and $1.0 billion to $1.2 billion for cropland erosion. (Baker-IVI)
W85-05941

RELATION BETWEEN TOXICITY AND FREE FORMS OF SOME TRACE METALS (RELATION ENTRE TOXICITE ET FORMS LIBRES DE QUELQUES METAUX TRACES),
Lille-2 Univ. (France). Unit of Pharmacy.
J. Pommery, M. Imbenotte, and F. Erb.
Environmental Pollution (Series B), Vol. 9, No. 2, p 127-136, 1985. 2 Fig, 4 Tab, 10 Ref.

Descriptors: *Toxicity, *Trace metals, Cadmium, Copper, Zinc, Humic acids, Daphnia, Heavy metals, Complexation.

The toxicity of trace metals, as free species or in complexed form with humic acids, has been studied by means of a medium-term daphnia test. Four parameters relative to sublethal effects and two lethal criteria were determined over a 30-day period. The toxicity due to metal concentrations (cadmium, 5 micro-g/liter; copper, 15 micro-g/liter and zinc, 50 micro-g/liter) was significantly established. Free metal concentrations were determined by differential pulse anodic stripping voltammetry and correlated with toxic effects. Comparison of the equations of the regression lines revealed that the effect of humic acids is not restricted to a pure detoxification by complexation. Their presence modifies the toxic behavior of free metals, as confirmed by the evaluation of the 30-day LC50. (Author's abstract)
W85-05976

CELLULAR METAL DISTRIBUTION IN THE PACIFIC OYSTER, CRASSOSTREA GIGAS (THUN.) DETERMINED BY QUANTITATIVE X-RAY MICROPROBE ANALYSIS,
Tasmanian Fisheries Development Authority, Taroona (Australia).
J. D. Thomson, B. J. S. Pirie, and S. G. George.
Journal of Experimental Marine Biology and Ecology, Vol. 85, No. 1, p 37-45, January, 1985. 2 Fig, 1 Tab, 22 Ref.

Descriptors: *Oysters, *Metals, *Derwent Estuary, *Tasmania, Water pollution effects, Copper, Zinc, Calcium, Iron, Heavy metals, Estuarine environment.

Both urban and industrial activities on the Derwent Estuary, Tasmania have resulted in elevated levels of metals in oysters. Mature oysters (Crassostrea gigas) were removed from a commercial oyster farm and retained in a pond at Crayfish Point on the Derwent Estuary for 4 months. Tissues of the oysters were examined using electron microscopy and the cellular metal concentrations measured by X-ray microanalysis. All tissues contained elevated copper and zinc concentrations. Calcium, iron, copper and zinc were present in the tertiary lysosomes, except in reproductive tissues. Only occasional membrane-limited vesicles were present in the gonad, and these contained very low concentrations of metals. In comparison with other animals, oysters have highly elevated tissue concentrations of Cu and Zn. Copper and zinc were selectively accumulated in membrane-limited vesicles of blood amoebocytes to cellular concentrations of approximately 70 mM Cu and 390 mM Zn and these amoebocytes contain > 90% of the body copper and zinc. Even in the reproductive tissues of these oysters, where the membrane-limited vesicles were not apparent, concentrations of 7-10 mM Ca, 0.2-0.8 mM Fe, 10-18 mM Cu and 26-30 mM Zn were found, and these must therefore be due to an elevated cytoplasmic concentration. (Moore-IVI)
W85-05995

SEPARATED DISTRIBUTION OF THE TWO VARIETIES OF ACHNANTHES MINUTISSIMA KUETZ. ACCORDING TO THE DEGREE OF RIVER WATER POLLUTION,
Tokyo Gakugei Univ. (Japan). Dept. of Biology.
S. Mayama, and H. Kobayasi.
Japanese Journal of Limnology, Vol. 45, No. 4, p 304-312, October, 1984. 5 Fig, 1 Tab, 28 Ref.

Descriptors: *Diatoms, *Distribution, *Water pollution effects, *Japan, *Tokyo, Urban areas, Rivers, Benthos.

Achnanthes minutissima var. minutissima is generally regarded as pollution-sensitive, while A. minutissima var. saprophila is considered to be one of the most pollution-tolerant diatoms. The distributions of these varieties were investigated in detail in the river waters of Tokyo (Japan) and vicinity. A total of 141 samples of benthic diatoms was collected from 52 station on 25 rivers which were estimated a alpha-mesosaprobic, alpha-meso/polysaprobic and polysaprobic. During the same period, 29 samples of benthic diatoms were taken from 15 stations estimated to be oligosaprobic, oligo/beta-mesosaprobic and beta-mesosaprobic on the Tama-gawa and Minamiasa-kawa. A. minutissima var. saprophila was found in 115 samples taken from 19 rivers including 46 sampling stations out of 52 in Tokyo. A. minutissima saprophila was found only in heavily to excessively polluted waters and even occurred as dominant or subdominant taxon in some samples. It did not universally occur in heavily to excessively polluted waters in high proportion, and was not observed in 6 of the 25 rivers. Vigorous growth was observed in the strongly polluted stretch of the Minamiasa-kawa. (Moore-IVI)
W85-06001

PRELIMINARY STUDY OF AQUATIC INSECT COMMUNITIES AND LEAF DECOMPOSITION IN ACID STREAMS NEAR DOREST, ONTARIO,
Toronto Univ. (Ontario). Dept. of Zoology.
R. J. Mackay, and K. E. Kersey.
Hydrobiologia, Vol. 122, No. 1, p 3-11, March, 1985. 3 Fig, 4 Tab, 32 Ref.

Descriptors: *Aquatic insects, *Leaves, *Decomposition, *Acid streams, *Ontario, Acid precipitation, Water pollution effects, Caddisflies, Stoneflies, Midges, Mayflies, Hydrogen ion concentration, Snowmelt.

Some streams near Dorset in south-central Ontario suffer from acid precipitation via run-off and seepage from thin soils with little buffering capacity. A spring-summer survey of eight headwater streams revealed some characteristics of their insect communities which could be correlated with pH. The streams could be divided into three groups according to pH and community structure. In the most acid group (annual pH range 4.3-4.8), Ephemeroptera were absent from two streams although mature Leptophlebia were collected just after spring thaw from the most acid one (pH 4.3-4.5). One of these three streams also lacked Plecoptera but the others had two or three genera, all shredders. The second group of three streams (pH 5.0-6.3), with one exception, did support Ephemerop-

tera (3-4 genera) and Plecoptera (1-4 genera), most of the latter being shredders. In all six of these acid streams, Trichoptera were more diverse and more dense than Ephemeroptera and Plecoptera; again, shredders were clearly dominant, especially the limnephilid caddisfly, Frenesia difficilis (Walker). These six streams also had similar chironomid communities (densities were an order of magnitude higher than other insects). Dominance by Chironomini and abundant Tanypodinae typified the most acid streams. In contrast, the two streams in the third group (pH 5.3-6.7) had richer and more balanced communities in general with relatively fewer shredders (no Frenesia), more collectors, and fewer Chironomini and Tanypodinae. As a field experiment showed that autumn-shed leaves decomposed more slowly in acid than in non-acid streams, summer-growing shredders may benefit from the pulse of acidity at snowmelt. (Author's abstract)
W85-06003

PHYSIOGRAPHY AND LIMNOLOGY OF THREE LAKES IN THE ENVIRONS OF THE UNION TERRITORY OF DELHI, INDIA,
Delhi Univ. (India). Ecology and Experimental Taxonomy Lab.
For primary bibliographic entry see Field 2H.
W85-06012

MERCURIC CHLORIDE INTOXICATION IN FRESHWATER PRAWN, II; EFFECT ON PHOSPHATASES ACTIVITY,
Gorakhpur Univ. (India). Dept. of Zoology.
R. Murti, Omkar, and G. S. Shukla.
Ecotoxicology and Environmental Safety, Vol. 8, No. 6, p 581-586, December, 1984. 1 Tab, 31 Ref.

Descriptors: *Mercuric chloride, *Prawns, *Enzyme activity, *Toxicity, Acid phosphatase, Alkaline phosphatase, Glucose-6-phosphatase, Water pollution effects, Mercury compounds.

The effects of mercuric chloride intoxication on the activities of acid and alkaline phosphatases and glucose-6-phosphatase in the hepatopancreas of a freshwater prawn Macrobrachium lamarrei (H. Milne Edwards) were determined after 24, 48, 72, and 96 hr. Mercuric chloride intoxication resulted in elevation of acid phosphatase and inhibition of alkaline phosphatase activities, but glucose-6-phosphatase activity was elevated up to 72 hr after which (i.e after 96 hr of exposure) inhibition in the enzyme activity was noted at two higher concentrations. Alterations in the activities of these enzymes after mercuric chloride intoxication have been shown to adversely affect the general metabolism of the freshwater prawn. (Author's abstract)
W85-06016

GUIDE FOR ASSESSING WATER-QUALITY IMPACTS OF HIGHWAY OPERATION AND MAINTENANCE,
R. R. Horner, and B. W. Mar.
Transportation Research Record, Vol. 948, p 31-40, 1984. 5 Fig, 2 Tab, 43 Ref.

Descriptors: *Water quality, *Highways, *Environmental effects, *Runoff, Washington, Water pollution sources, Evaluation, Toxicity, Organic compounds, Metals, Rainfall.

A procedure for assessing highway runoff water quality has been formulated on the basis of a large data base that represents conditions prevalent in the state of Washington. The procedure consists of a component for predicting total pollutant loadings over an extended time period and a series of charts with which the impacts of individual events can be assessed probabilistically. A significant finding was that highway runoff in Washington State contains lower levels of contamination than general urban drainage and, in normal runoff events, does not have a substantial impact on the quality of receiving water. Limited problem areas were identified and thus a basis was provide for reducing mitigation costs overall and applying resources to those cases most in need of attention. (Baker-IVI)
W85-06068

HYDROGEOCHEMICAL ASPECTS OF SURFACE MINE RECLAMATION IN THE NORTHERN GREAT PLAINS,
North Dakota Mining and Mineral Resources Research Inst., Grand Forks.
For primary bibliographic entry see Field 4C.
W85-06076

EFFECTS OF FOUR AROMATIC ORGANIC POLLUTANTS ON MICROBIAL GLUCOSE METABOLISM AND THYMIDINE INCORPORATION IN MARINE SEDIMENTS,
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
J. E. Bauer, and D. G. Capone.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 828-835, April, 1985. 4 Fig, 3 Tab, 23 Ref.

Descriptors: *Aromatic compounds, *Bacterial metabolism, *Glucose, *Thymidine, *Sediments, Isotope studies, Microorganisms, Anthracene, Napthalene, Dichlorodiphenyltrichloroethane, Pentachlorophenol, Toxicity, Water pollution effects, Aerobic conditions, Anaerobic conditions, Bioindicators.

The metabolism of D-(U-C-14)glucose and the incorporation of (methyl-H-3)thymidine by aerobic and anaerobic marine sediment microbes exposed to 1 to 1,000 ppm anthracene, naphthalene, p,p'-dichlorodiphenyltrichloroethane, and pentachlorophenol were examined. Cell-specific rates of (C-14)glucose metabolism averaged 1.7 x 10 to the 21st power mol/min per cell for aerobic and anaerobic sediment slurries, respectively; (H-3)thymidine incorporation rates averaged 43 x 10 to the minus 24th power and 9 x 10 to the minus 24th power mol/min per cell for aerobic and anaerobic slurries, respectively. Aerobic sediments exposed to three of the organic pollutants for 2 to 7 days showed recovery of both activities. Anaerobic sediments showed little recovery after 2 days of pre-exposure to the pollutants. It is concluded that (i) anaerobic sediments are more sensitive than aerobic sediments to pollutant additions; (ii) (H-3)thymidine incorporation is more sensitive to pollutant additions than is (C-14)glucose metabolism; and (iii) the toxicity of the pollutants increased in the following order: anthracene, p,p'-dichlorodiphenyltrichloroethane, naphthalene, and pentachlorophenol. (Author's abstract)
W85-06143

CATASTROPHIC ANOXIA IN THE CHESAPEAKE BAY IN 1984,
Johns Hopkins Univ., Baltimore, MD. McCollum-Pratt Inst.
For primary bibliographic entry see Field 2L.
W85-06159

ERYTHROCYTIC AND LEUKOCYTIC RESPONSES TO CADMIUM POISONING IN A FRESHWATER FISH, PUNTIUS CONCHONIUS HAM,
D.S.B. Constituent Coll., Naini Tal (India). Dept. of Zoology.
T. S. Gill, and J. C. Pant.
Environmental Research, Vol. 36, No. 2, p 327-337, April, 1985. 12 Fig, 2 Tab, 35 Ref.

Descriptors: *Cadmium, *Fish, *Toxicity, Blood, Water pollution effects, Heavy metals, Chronic toxicity.

Chronically sublethal concentrations of cadmium caused conspicuous hematological anomalies in the cyprinid fish, Puntius conchonius. Exposure to 0.63 and 0.84 mg/liter cadmium chloride (1/20 and 1/15 of 96-hr LC50) induced morphological aberrations in mature erythrocytes including cytoplasmic vacuolation, hypochromia, deterioration of cellular membrane, basophilic stippling of cytoplasm, clumping of chromatin material and extrusion of nuclei, and schistocytosis. Anomalous basophils and monocytes were also encountered though less frequently. Decreased erythrocyte counts, hemoglobin and hematocrit values were also associated with chronic cadmium poisoning. The mean corpuscular hemoglobin and mean corpuscular volume increased (30 days) but mean corpuscular hemoglobin concentration showed no obvious change. A significant thrombocytopenia (90 days), elevated small lymphocyte and basophil populations, and a mild neutropenia were manifested in the cadmium-exposed fish. Large lymphocytes were not significantly affected. (Author's abstract)
W85-06167

EVALUATION OF CARBAMATE TOXICITY: ACUTE TOXICITY IN A CULTURE OF PARAMECIUM MULTIMICRONUCLEATUM UPON EXPOSURE TO ALDICARB, CARBARYL, AND MEXACARBATE AS MEASURED BY WARBURG RESPIROMETRY AND ACUTE PLATE ASSAY,
Wisconsin Univ.-Parkside, Kenosha.
C. E. Edmiston, Jr., M. Goheen, G. W. Malaney, and W. L. Mills.
Environmental Research, Vol. 36, No. 2, p 338-350, April, 1985. 9 Fig, 2 Tab, 27 Ref.

Descriptors: *Carbamates, *Toxicity, *Paramecium, Protozoa, Aldicarb, Carbaryl, Mexacarbate, Pesticide toxicity, Metabolism, Oxygen uptake, Respirometry.

The present study was undertaken to explore the acute toxicity of the three carbamate pesticides, aldicarb, carbaryl, and mexacarbate, on a population of Paramecium multimicronucleatum. The toxicity was evaluated by the Warburg respirometer and the static acute plate assay. Aldicarb, carbaryl, and mexacarbate were shown to significantly inhibit cumulative oxygen uptake at 24 hr in the paramecium culture at 160, 120, and 100 ppm, respectively. Aldicarb, carbaryl, and mexacarbate concentrations of 60, 20, and 10 ppm demonstrated no inhibition of cumulative oxygen uptake when compared to a paramecium control at 24 hr. Pesticide concentrations intermediate to the high and low concentrations demonstrated varying degrees of inhibition. Static plate assay data for aldicarb demonstrated LC50 values of 93, 104, 122, and 145 ppm at 24, 17, 13, and 9 hr, while carbaryl demonstrated LC50 values of 28, 34, 46, 65, and 105 ppm at 24, 17, 13, 9, and 7 hr, respectively. Mexacarbate LC50 values were 19, 25, 35, 57, and 83 ppm at 24, 17, 13, 9, and 7 hr. Oxygen uptake values compared favorably with the static assay data. Scanning electron micrographs demonstrated several morphologic changes in paramecium with increased pesticide concentration and exposure time including ciliary abnormalities and disruption of surface structure. (Author's abstract)
W85-06168

MERCURY, SELENIUM, ARSENIC AND ZINC IN WADERS FROM THE DUTCH WADDEN SEA,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
A. A. Goede.
Environmental Pollution (Series A), Vol. 37, No. 4, p 287-309, 1984. 6 Fig, 4 Tab, 60 Ref.

Descriptors: *Metals, *Birds, *Wadden Sea, *Netherlands, Mercury, Selenium, Arsenic, Zinc, Toxicity, Heavy metals, Water pollution effects.

The river Rhine carries pollutants, including heavy metals, to a large estuarine area, the Wadden Sea, off the Netherlands. The metal contamination of waders (knots, redshanks, and godwits) in the Wadden Sea was investigated using the primaries (feathers) formed in this area as a monitoring tissue. Elevated levels of mercury in feathers were found in adult waders. A cautious estimate for knots and redshanks from Schiermonnikoog gives at least a 5-fold elevation in concentration. Even though feather concentrations were high, liver and kidney concentrations were relatively low just after molt. A negative correlation was found between mercury and selenium in concentrations in the liver. Selenium may have been excreted via the feather oils which contaminated the feathers. All but one juvenile had no detectable amounts of arsenic in the shaft. Compared with these, the adults from the Wadden Sea had elevated levels. Significant differences in concentrations were

noted in the different sampling years in redshanks and male godwits from Schiermonnikoog. In all juveniles from past and present samples, the range of vane zinc concentrations amounted to 100-400 mg/kg. In most cases significant positive correlations were found between arsenic concentrations in the kidney and in the liver. Similarly selenium concentrations in kidney were related to those in the liver and a negative correlation was found between selenium in the liver and mercury in the liver. (Baker-IVI)
W85-06169

LEAD AND CADMIUM IN WADERS FROM THE DUTCH WADDEN SEA,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
A. A. Goede, and P. de Voogt.
Environmental Pollution (Series A), Vol. 37, No. 4, p 311-322, 1984. 1 Fig, 3 Tab, 18 Ref.

Descriptors: *Waders, *Birds, *Lead, *Cadmium, *Wadden Sea, Heavy metals, Feathers, Pollutant identification, Water pollution effects, Zinc protoporphyrin.

The Wadden Sea is a large marine area in the northern part of the Netherlands and Federal Republic of Germany, and the western part of Denmark. The contamination of this area present a potential hazard for the many wader species present for the post-nuptual molt. In the Dutch Wadden Sea, three wader species (knot, Icelandic redshank, and bartailed godwit) were investigated for lead and cadmium concentrations, using mainly feathers as the monitoring tissue. The exposure to Pb was studied by means of a relatively new method, the zinc protoporphyrin concentration in the blood of the waders. The rapid accumulation of Pb in the vanes of juveniles after arrival in the Wadden Sea and the elevated levels the the adult vanes grown in this area indicate that waders are exposed to Pb. The situation with regard to cadmium did not seem to be serious. (Moore-IVI)
W85-06170

WATER QUALITY VARIATIONS AND CONTROL TECHNOLOGY OF YAMUNA RIVER,
Roorkee Univ. (India). Dept. of Civil Engineering.
D. S. Bhargava.
Environmental Pollution (Series A), Vol. 37, No. 4, p 355-376, 1985. 3 Fig, 4 Tab, 12 Ref.

Descriptors: *Water quality, *Yamuna River, *India, *Water quality control, Seasonal variation, Rivers, Water pollution sources, Water pollution effects, Water pollution control, Wastewater pollution, Pollution load.

The Yamuna River (India) is one of the important rivers of the Indogangetic plain. A water quality survey of the Yamuna River was undertaken to determine the variations in the quality of this river along its course during both summer and winter. There is considerable human activity along the course of the river, including domestic, commercial, agricultural and industrial activities, and, as a result, different types of waste material enter the river, continuously altering its water quality. A water quality index representing the integrated effect of the concentrations and relative importance of the parameters is used to denote degradation of the river quality. Stretches of the river are identified which require quality upgrading. A comprehensive strategy is presented for improving the water quality of the river. The defensive approaches would aim at reducing the pollution load on the river through proper planning, treatment and disposal of wastewater. The offensive approaches should aim at the fullest exploitation and improvement in the waste assimilative capacity of the river, so that the river quality can be enhanced. (Moore-IVI)
W85-06171

5D. Waste Treatment Processes

EFFECT OF PH ON THE UPTAKE OF ZINC, COPPER AND NICKEL FROM CHLORIDE SOLUTIONS BY AN UNCONTAMINATED SEWAGE SLUDGE,
Rothamsted Experiment Station, Harpenden (England). Dept. of Soils and Plant Nutrition.
T. McM. Adams.
Environmental Pollution (Series B), Vol. 9, No. 2, p 151-161, 1985. 6 Fig, 2 Tab, 10 Ref.

Descriptors: *Sludge, *Zinc, *Copper, *Nickel, *Hydrogen ion concentration, Cation exchange, Adsorption, Heavy metals, Wastewater treatment, Complexation.

The uptake of zinc, copper and nickel by an uncontaminated sewage sludge was studied as a function of added metal concentration and of pH. The quantity of metal taken up at constant pH increased with added metal concentration up to an apparent saturation value in some cases, but the data did not fit Langmuir or Freundlich adsorption isotherms closely. The proportion of total metal in the solution phase at a given pH in these uptake experiments was generally larger than that in the solution phase in comparable experiments involving the release of the metals into solution from metal-contaminated sludges, to which the metals had been added during sewage treatment. Differences between the cation exchange capacity of uncontaminated and of metal-loaded sludges were used to calculate the amount of metal held on cation exchange sites by complexation in the metal-loaded sludges. The amount of exchangeable metal was determined by displacement with barium. The proportion of total metal held on the sites in exchangeable and complexed forms in metal-loaded sludges is 52% of zinc, 71% of copper and 92% of nickel. (Author's abstract)
W85-05977

PROGRESS IN MUNICIPAL PHOSPHORUS CONTROL,
Windsor Univ. (Ontario). Great Lakes Inst.
For primary bibliographic entry see Field 5G.
W85-05981

PRELIMINARY TREATMENT OF CHEMICAL WASTEWATER BY MEANS OF SEDIMENTATION AND PRESSURE-RELEASE FLOTATION (VORKLARUNG VON CHEMIEABWASSER DURCH SEDIMENTATION UND ENTSPANNUNGSFLOTATION),
Hoechst A.G., Frankfurt-am-Main (Germany, F.R.). Verfahrenstechnik.
H. Bennoit.
Chemie Ingenieur Technick, Vol 57, No. 2, p 158-159, February, 1985. 2 Fig, 4 Ref.

Descriptors: *Industrial wastewater, *Sedimentation, *Pressure-release flotation, Wastewater treatment, Flotation, Wastewater inflow, Hydraulic surface load, Solids reduction.

Pressure-release flotation (PRF) was compared with sedimentation for preliminary treatment of insoluble components of chemical wastewater with highly variable levels of pollution. A continuous wastewater-treatment facility (maximal capacity 12 cu m/hr) was used, consisting of a first chemical/physical-treatment stage (precipitation and two-stage neutralization to pH 8-9) and a second stage in which wastewater is divided, passing through a 4.5-cu-m vertical-flow thickening tank and a 1.5-cu-m rectangular flotation facility. A relatively constant separation level of 90-98% was seen with PRF at 20% pressurized-water input and 4-bar saturation pressure with a wastewater inflow of 4 cu m/sq m h; at 3 cu m/sq m h, values were close to 98%, denoting a 2-10 mg/l concentration of undissolved solids in treated wastewater. The flotation facility reached a limit in efficiency at wastewater inflow/hydraulic surface load of 5-6 cu m/sq m h with resulting flow-through time of 15 min. Variation of the two control parameters in pressurized-water application did not result in improved separation levels; eg, 30% pressurized-water input resulted in solids reduction in outflow of only 68-80% (due to an excessively high surface load of 6.5 cu m/sq m h). (Gish-IVI)
W85-05983

REMOVAL OF METALS FROM SLUDGE USING CHITOSAN COLUMNS,
Cornell Univ., Ithaca, NY. Dept. of Food Science.
T. Yang, and R. R. Zall.
Industrial Water Engineering, Vol. 21, No. 4, p 16-20, July/August, 1984. 10 Fig, 2 Tab, 13 Ref.

Descriptors: *Sludge treatment, *Metals, *Chitosan, Wastewater treatment, Water pollution control, Sludge, Copper, Zinc, Cadmium, Chromium, Lead.

The feasibility of using chitosan columns to remove selected metals from sludge was investigated. Column performance was evaluated on the basis of breakthrough curves. In addition, different operational factors such as particle size, bed depth, flow rate, influent concentration and pH were studied. The work was limited to the removal of selected metals using chitosan in bench-top studies with a laboratory size column. The project provides information which may contribute to the development of column systems with chitosan for use as a tertiary treatment process. Four liters of a solution with 100 ppm concentration of each of the test metals, Cu, Zn, Cr, Cd, and Pb, were introduced to the bottom of the column. The study indicated that a column system charged with chitosan is able to be used to remove metals from sludge. (Baker-IVI)
W85-05994

LAND TREATMENT OF WASTES: CONCEPTS AND GENERAL DESIGN,
Texas Univ. at Austin.
R. C. Loehr, and M. R. Overcash.
Journal of Environmental Engineering, Vol. 111, No. 2, p 141-160, April, 1985. 3 Fig, 8 Tab, 7 Ref.

Descriptors: *Land disposal, *Wastewater treatment, *Waste treatment, Municipal wastes, Industrial wastes, Decision making, Costs, Evaluation, Data acquisition, Site selection.

Land treatment is a managed treatment and ultimate disposal process that involves the controlled application of a municipal or industrial waste to a soil or soil-vegetation system. The objective of land treatment is the biological degradation of organic waste constituents and the immobilization of inorganic waste constituents. The design methodology for land treatment includes several stages of data acquisition, waste and site evaluation, and consideration of approaches to minimize total system costs. The limiting constituent concept is identified as the basis of successful design and operation of land treatment systems. The concept provides a standard methodology for considering important site-specific soil data, climatic conditions, waste characteristics, and environmental concerns. It is based upon the nondegradation concept and embodies information from many disciplines to avoid adverse environmental impacts. Land treatment can be used with wastes that have different characteristics and land limiting constituents. This approach can be used with any waste to determine the technical and economic feasibility of this technology. (Moore-IVI)
W85-06018

PRACTICAL STEPS LEADING TOWARD THE EFFLUENT-FREE MILL,
Sappi Ltd., Johannesburg (South Africa).
B. Coetzee, C. J. Davies, F. E. Mera, and L. K. Swift.
Tappi Journal, Vol. 68, No. 4, p 92-97, April, 1985. 6 Fig, 4 Tab, 3 Ref.

Descriptors: *Pulp and paper industry, *Water pollution control, *Design criteria, Industrial wastes, Water quality control, Water management, Water reclamation.

A new, 1500 ton/day, totally integrated, multigrade bleached kraft pulp mill is designed to operate with what may be the lowest effluent discharge of any similar mill in the industry. The Ngodwana mill in South Africa operates under a unique set of environmental constraints, with some of the most modern technologies and innovative measures

having been applied to minimize water usage. Two major drawbacks at the mill include the limited nature of the water supply and the fact that no receiving stream or body of water could be used for disposing of effluent emanating from the mill. At the facility unbleached chemical pulp is produced on both the existing 300-ton/day fiber line and a new continuous fiber line rated at 750 tons/day. The fiber line is followed by an OD/CED bleach plant that can produce fully bleached or semibleached pulp. Additional pulp furnished is provided by a 330-ton/day groundwood mill utilizing both atmospheric and stone grinders and a secondary fiber plant rated at 100 tons/day. Design features employed at the mill to minimize water requirements include spill collection systems, closed seal water systems, evaporator condensates, cooling towers, closed vacuum pump cooling systems, paper machines, OD/CED bleaching, and a number of built in options. (Baker-IVI)
W85-06058

TEN YEARS OF EXPERIENCE WITH SUBSURFACE INJECTION,
Black and Veatch, Aurora, CO.
S. B. Smith, C. P. Houck, and J. L. Smith.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1771-1779, November-December, 1984. 1 Fig, 10 Tab, 12 Ref.

Descriptors: *Subsurface injection, *Wastewater disposal, Heavy metals, Environmental impact, Sludge disposal, Groundwater contamination, Crop production.

The subsurface injection of sludge has proven to be a viable operation that conserves natural resources. Fifteen different sites have been developed, and the operational components of each site are discussed, including management techniques and equipment selection for inclement weather conditions. Several sites have been further evaluated for environmental effects including ground water, soil, crop, and percolate quality. Analyses results indicate that heavy metals applied in the sludge have been retained in the soil and have not been available for plant uptake on near-neutral pH soils and that there has been no detectable degradation of the environment caused by the application of sludge. (Author's abstract)
W85-06086

MULTISPECIES MODEL OF BIOLOGICAL TREATMENT WITH SEQUENTIAL POLLUTANT OXIDATION,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. B. Vasiliev, and V. A. Vavilin.
Biotechnology and Bioengineering, Vol. 27, No. 4, p 490-497, April, 1985. 6 Fig, 2 Tab, 7 Ref.

Descriptors: *Biological wastewater treatment, *Model studies, *Oxidation, Activated sludge process, Microorganisms, Wastewater treatment, Pollutant load.

A multicomponent multispecies biological treatment model of biological wastewater treatment was used to study sequential pollutant oxidation. Under a sequential oxidation mechanism there will be adjustments of species distribution in sludge to the particular operational regime of a treatment plant. The effects of such adaptation under sequential and under simultaneous oxidation mechanisms would be generally similar. The steady-state distribution of species in activated sludge is dependent on the level of organic loading. Under large loadings, fast-growing species will predominate in the sludge microflora, while at low loadings, the slow-growing one will predominate. Under periodic loading variations, an adjustment of the species distribution to the average loading level will take place. (Moore-IVI)
W85-06166

5E. Ultimate Disposal Of Wastes

TEN YEARS OF EXPERIENCE WITH SUBSURFACE INJECTION,
Black and Veatch, Aurora, CO.
For primary bibliographic entry see Field 5D.
W85-06086

5F. Water Treatment and Quality Alteration

ENVIRONMENTAL HEALTH INVESTIGATION OF COPPER INTOXICATION FROM A PUBLIC WATER SUPPLY,
Vermont State Dept. of Health, Burlington. Div. of Environmental Health.
H. E. Sargent, and H. Jean.
Journal of the New England Water Works Association, Vol. 98, No. 4, p 347-362, December, 1984. 1 Fig, 3 Tab, 6 Ref.

Descriptors: *Public health, *Copper, *Drinking water, *Jeffersonville, *Vermont, Water pollution effects, Toxicity, Pipes, Water distribution, Corrosion.

An environmental investigation is presented of drinking water induced copper toxicosis in a family served by the Jeffersonville, Vermont water system. A 500 ft long type K copper main serves five homes on a deadend street. Family A, at the end, is the family which reported alleged problems on ingesting the village water. The average copper content of all 423 public supplies in Vermont at their sources is 0.046 mg/L. The average of all yearly distribution samples is 0.983 mg/L, suggesting that copper is commonly used as a pipe material in Vermont and that the water is to some degree aggressive. Samples of water taken from the home of Family A showed a range of 2.8 to 7.8 mg Cu/l which caused the village trustees to decide to replace the 500 feet of copper main. The father and two daughters often became ill 5 to 20 minutes after drinking water. While blood levels of copper were normal for family A, hair samples showed elevated copper levels and a nail clipping also showed elevated copper levels. The village also reviewed the aggressive nature of their water in efforts to reduce this through chemical treatment. Until such steps are taken all residents have been advised to run their water for a minute on first use each morning to clear the line of any accumulated copper and lead. (Baker-IVI)
W85-05913

ALUMINUM IN DRINKING WATERS,
New Hampshire Univ., Durham. Dept. of Civil Engineering.
W. Sung, W. J. Gallot, R. Gottlieb, and D. A. Viscardi.
Journal of the New England Water Works Association, Vol. 98, No. 4, p 363-389, December, 1984. 5 Fig, 2 Tab, 31 Ref.

Descriptors: *Aluminum, *Drinking water, *Alum, *Water treatment, Coagulation, Turbidity, Color, Hydrogen ion concentration, Temperature effects, Public health.

Aluminum, in the form of alum, an aluminum sulfate, is often used in water treatment plants in the coagulation process for removing color and turbidity. Recent advances on the conceptual developments on color and turbidity removal mechanisms with alum are reviewed. An optimum control strategy has been developed for color and turbidity removal. Equilibrium calculations are used in the interpretation of observed aluminum behavior. The total amount of residual aluminum leaving a water treatment plant includes dissolved and particulate aluminum. Dissolved aluminum is determined by pH, the presence of ligands and temperature while the amount of particulate aluminum is dependent on the actual performance of sedimentation and filtration. In jar tests in this study the residual aluminum ranged from about 20 to 80 micro-g/l and consisted of both dissolved and particulate aluminum. (Baker-IVI)
W85-05914

TARGETED CHLORINATION IS VIABLE AND ENVIRONMENTALLY ACCEPTABLE,
Tennessee Valley Authority, Chattanooga.
R. D. Moss, S. P. Gautney, and P. A. March.
Power, Vol. 129, No. 2, p 79-81, February, 1985. 5 Fig, 13 Ref.

Descriptors: *Chlorination, *Water treatment, *Cooling water, Biofouling, Powerplants, Economic aspects, Effluents, Targeted chlorination, Condenser tubes.

Potential plugging of condenser tubes makes biological fouling a leading problem in cooling-water systems. Chlorine is an effective biocide, but concern for adverse environmental effects of escaping residual chlorine has fostered efforts to optimize application efficiencies while limiting chlorine in effluents to tolerable levels. The concept of targeted chlorination (TC) is to sequentially chlorinate a few condenser tubes at a time, using high enough chlorine concentrations to destroy micro-organisms present in those tubes. By mixing the small amount of discharged chlorinated water with the rest of the cooling water at the condenser outlet, the concentration at the plant discharge can be held within EPA limits. A 1:6-scale model of the Kingston condenser was built to provide velocity data, flow-distribution data, and concentration data regarding three types of TC systems: manifold against tubesheet, nozzles in inlet pipes, and nozzles in the inlet waterbox. A full-scale mockup test was conducted to ensure that all the mechanical parts functioned as designed. An economic evaluation was conducted to assess the costs of various alternatives for treatment to meet EPA effluent limits. (Baker-IVI)
W85-05916

APPLICATION OF A NEW ENVIRONMENTALLY ACCEPTABLE COOLING WATER TREATMENT,
T. W. Isaac, A. J. Korvin, and R. S. Klonowski.
Industrial Water Engineering, Vol. 21, No. 3, p 18-23, May-June, 1984. 9 Fig, 5 Tab, 10 Ref.

Descriptors: *Industrial water, *Water treatment, *Cooling water, Corrosion control, Organophosphonates, Triazoles, Polymers.

Cooling water corrosion inhibitors which provide effective control and have negligible effect on the environment are in great demand due to the increasingly stringent limitations being placed on industrial effluents by various agencies. A specific blend of chlorine resistant organophosphonate in combination with a triazole and a low molecular weight polymeric diol is evaluated. The key ingredient is the polymeric compound which enhances the synergistic corrosion inhibition of organophosphonate with triazole in both alloy metal and steel systems. A large number of different polymeric diols in combination with phosphonate and triazole were initially screened for corrosion inhibition potential. (Baker-IVI)
W85-05991

WHY OZONE IS A VIABLE ALTERNATIVE TO CHEMICALS FOR THE TREATMENT OF COOLING TOWER AND HEAT EXCHANGER WATER,
United States Ozonair Corp., South San Francisco, CA.
K. Stopka.
Industrial Water Engineering, Vol. 21, No. 3, p 24-29, 1984. 3 Tab.

Descriptors: *Cooling water, *Industrial water, *Water treatment, *Ozone, Heat exchangers, Water pollution control, Disinfection, Blowdown, Turbidity.

The occurrence in cooling towers of various pathogens such as the one responsible for Legionnaires' Disease and the ineffectiveness of chemical treatment against these pathogens, has prompted the investigation of ozone as a viable alternative to chemical treatment. The advantages of ozone over chemical treatment are: elimination of blow down, prevention of algae growth and scale, complete control of microbial life, simplicity of operation and very little maintenance, no pH control, no storage of chemicals or hazards; and, depending on

the size of the cooling tower, economic payback in a reasonable period of time. Experience with ozone in the treatment of cooling tower water is briefly reviewed. Besides highly efficient sterilization, microflocculation which takes place after ozonation and the removal of organic slime are the main reasons why, a year later, without a single blow down, the turbidity of the ozonated water is superior to chemically treated city water. (Baker-IVI)
W85-05992

REVERSE OSMOSIS MEMBRANE FOULING AND PRETREATMENT CONSIDERATIONS,
For primary bibliographic entry see Field 3A.
W85-05993

OPTIMAL EXPANSION OF WATER DISTRIBUTION SYSTEMS,
Visvesvaraya Regional Coll. of Engineering, Nagpur (India). Dept. of Civil Engineering.
P. R. Bhave.
Journal of Environmental Engineering, Vol. 111, No. 2, p 177-197, April, 1985. 4 Fig, 5 Tab, 27 Ref, 1 Append.

Descriptors: *Water conveyance, *Optimization, *System expansion, Systems engineering, Pipes, Tunnels, Looped systems, Design.

Water distribution systems can be of the branching type generally used for small communities, or of the looped type used mostly for urban areas. The discharge in the links of looped distribution systems cannot be fixed uniquely; therefore, their optimal design is rather difficult. A method for the optimal expansion of water distibution systems subjected to a single loading pattern is developed. The method optimally decides the pumping heads at new source nodes, if any, and also optimally selects the links which need strengthening to improve the delivery capability of the existing system. The method is iterative and converges rapidly to a local but fairly good optimal solution. Optimization of an entirely new distribution system is a particular characteristic of this general approach. The method is also suitable for hand calculation for small systems. The method is illustrated through an example and application to the New York City water supply tunnel system. The procedure can possibly be extended to time-varying conditions, such as are found in actual practice. (Moore-IVI)
W85-06020

SOURCE OF DEIONIZED WATER FOR HIGH-PRESSURE STEAM,
Sybron Chemical Div., Birmingham, NJ.
F. X. McGarvey, M. Moldofsky, and S. Beran.
Tappi Journal, Vol. 67, No. 8, p 58-61, August, 1984. 7 Fig, 3 Tab, 10 Ref.

Descriptors: *Pulp and paper industry, *Water management, *Deionized water, Engineering, Design criteria, Industrial water, Water quality, Ion exchange processes, Purification, Water treatment.

Paper mills use a lot of water, frequently demanding more than 20,000 gal/ton of finished paper products. Water usage has become more efficient in recent years but the trend to high pressure steam generation has placed special demands on the water quality to be used for boiler feed. Mill locations are such that sources of good quality water are quite limited. Field experiences in treating these waters relate particularly to organic fouling of strong base resins, the removal of colloidal silica by macroporous strong base resins, and economic evaluation of the ion-exchange process. An accurate analysis of inorganic salts is an important requirement for the design of a plant to produce a high quality deionized water. Treatment for organic substances and silica is also reviewed and a typical paper mill feedwater system is diagrammed. (Baker-IVI)
W85-06061

SURVEY OF THE USE OF ACTIVATED CARBON WATER FILTERS IN CANADIAN HOMES,
Health and Welfare Canada, Ottawa (Ontario). Health Protection Branch.
R. S. Tobin, E. A. Junkins, and F. E. Eaton.
Canadian Journal of Public Health, Vol. 75, No. 5, p 384-387, September-October, 1984. 3 Tab, 18 Ref.

Descriptors: *Activated carbon, *Domestic water, *Canada, *Filters, Surveys, Water treatment, Public health.

Activated carbon filters are used in many Canadian homes to improve the asthetic qualities of water and to remove some chemical constituents. The filtering mechanism of activated carbon provides a rich nutrient base derived from the water for any entrapped bacteria that can subsequently multiply and be released into the effluent water. As part of the evaluation of the possible health risk from the use of activated carbon in home water treatment devices, a survey was conducted to estimate how many Canadians use activated carbon filters and to determine how they are used. Filters containing activated carbon are used in 1.4% of all households in the 16 cities surveyed. In these centers, about 160,000 people are exposed to water that has passed through activated carbon filters, by direct ingestion of water or in drinks, contamination of food, inhalation of aerosols, contact with wounds or skin, immersion of the body while bathing or in the shower, and by contamination of humidifiers and vaporizers. (Author's abstract)
W85-06102

REDUCING THE COST OF HIGH TECHNOLOGY WATER TREATMENTS,
J. Cross.
Water and Waste Treatment, Vol. 28, No. 3, p 33-34. March, 1985. 3 Fig.

Descriptors: *Water treatment, *Economic aspects, Pretreatment, Membrane processes, Reverse osmosis, Ultrafiltration, Pharmaceutical industry, Beverage industry, Industrial water.

Pretreatment can cut replacement of the various parts or a water treatment system. To reduce fouling of the membrane in a reverse osmosis (RO) process, which should reduce the output and quality of the permeate, the feedwater to RO plants must be pretreated. The design of the pretreatment package will be determined largely by the quality of the raw water, in particular, the total hardness, the level of dissolved iron and the degree of colloidal contamination. In ultrafiltration systems, an automatic flushing mechanism should be included which ensures that the modules are regularly backwashed. Both reverse osmosis and ultrafiltration membranes are able to retain the large contaminants found in water supplies. Both can thus be used to extend the lifespan of downstream submicron filters with substantial savings in the cost of replacements. Case histories of cost reduction measures are examined for a boiler feedwater system, the soft drinks industry, and the pharmaceutical industry. (Baker-IVI)
W85-06123

TRENDS IN DRINKING WATER TREATMENT; THE SHAPE OF THINGS TO COME - PART I, REGULATORY DIRECTION,
Metcalf and Eddy of New York, NY.
G. P. Fulton.
Public Works, Vol. 116, No. 4, p 55-57, April, 1985. 3 Tab.

Descriptors: *Water quality control, *Drinking water, *Regulations, Public participation, Water management, Organic compounds, Pesticides, Particulates, Pathogens.

In the late 1960s and early 1970s the development of new analytical equipment and procedures enabled minute quantities of potentially harmful compounds present in water supply sources to be discerned. In the area of organic contaminants, much controversy has been generated with the result that the water supply industry has delayed decision on the handling of the organic contaminant problems except for three groups of such constituents: total trihalomethanes, herbicides and pesticides. Public concern and pressures have each played a part in the growing pressures placed on water treatment authorities. Water quality and treatment directions are reviewed for the areas of esthetics, particulates, pathogens, inorganics, and organics. (Baker-IVI)
W85-06124

RELATIVE RESISTANCE TO CHLORINE OF POLIOVIRUS AND COXSACKIEVIRUS ISOLATES FROM ENVIRONMENTAL SOURCES AND DRINKING WATER,
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
P. Payment, M. Tremblay, and M. Trudel.
Applied and Environmental Microbiology, Vol. 49, No. 4, p 981-983, April, 1985. 1 Tab, 3 Ref.

Descriptors: *Chlorine, *Poliovirus, *Coxsackievirus, *Viruses, *Drinking water, *Disinfection, Water treatment, Enteroviruses.

Several poliovirus and coxsackievirus isolates from environmental sources were compared with laboratory strains to determine their rate of inactivation by chlorine. All viruses were tested for up to 1,000 min in the presence of an initial free residual chlorine level of ca. 0.4 mg/liter. Coxsackievirus B5 (CB-5) isolates were found to be more resistant to chlorine than coxsackievirus B4 (CB-4), followed by poliovirus 1, 2, and 3 in order of decreasing resistance to chlorine. Environmental isolates of CB-5 were more resistant than the laboratory strain tested, and for two strains 12 and 22% of the input virus was still infectious after 100 min in the presence of free residual chlorine. Although CB-4 isolates were less resistant to chlorine than CB-5 isolates, isolates from environmental sources did not appear to be more resistant to chlorine than laboratory strains. Viruses isolated at different phases during the preparation of drinking water were not more resistant to chlorine and must thus have been protected by other mechanisms. (Author's abstract)
W85-06147

5G. Water Quality Control

AQUIFER PROTECTION PLANNING: GROUNDWATER PROTECTION IN TWO MASSACHUSETTS COMMUNITIES,
Lexington, KY.
S. M. Kilner, W. J. Rizzo, and J. F. Shawcross.
Journal of the New England Water Works Association, Vol. 98, No. 4, p 325-346, December, 1984. 5 Fig, 1 Tab, 4 Ref.

Descriptors: *Groundwater protection, *Drinking water, *Burlington, *Littleton, *Massachusetts, Decision making, Water quality control, Aquifers, Water pollution control.

The Aquifer Protection Plans of two communities, Burlington and Littleton, Massachusetts, were developed for different reasons. The stimulus in Burlington was predominantly remedial as it had lost one of its wells to trichloroethylene contamination. The objective in Littleton was primarily preventive; the community was in the process of selecting a new well site and wanted to assure the long term protection of its quality. Attention is given to the planning process to be used in aquifer protection decision making problems, sampling programs to identify the contamination source in Burlington, regulations of concern, implementation and enforcement of new regulations, steps to be taken in selecting a location for a new well, and the protection plan. The most profound conclusion that was drawn from the study was that the traditional approach to well siting and groundwater protection is inadequate. A second conclusion is that of the need for regional treatment and protection of groundwater quality. It was also apparent that despite the sanctity and acceptance of the need for safe drinking water, the process of actually protecting it is fraught with controversy, and compromises are inevitable. The matter of the cost of administering the protection program is also considered. (Baker-IVI)
W85-05912

TARGETED CHLORINATION IS VIABLE AND ENVIRONMENTALLY ACCEPTABLE,
Tennessee Valley Authority, Chattanooga.
For primary bibliographic entry see Field 5F.
W85-05916

AGRICULTURAL NONPOINT POLLUTION CONTROL: AN ASSESSMENT,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
J. B. Braden, and D. L. Uchtmann.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 23-26, January-February, 1985. 33 Ref.

Descriptors: *Water pollution control, *Agriculture, *Nonpoint pollution sources, Sediment transport, Water quality control, Soil conservation, Legislation, Regulations.

Links between agriculture and water quality are both obvious and elusive. General relationships are easy to accept, but far less is known about the underlying hydrological or biochemical processes. EPA reported that water quality conditions remained stable for most bodies of water in the US between 1970 and 1980. The traditional soil conservation agencies dominate most state programs for reducing nonpoint agricultural pollution. Important changes concerning the availability of conservation agency services have been induced mainly by the new environmental responsibilities. In some states conservation agencies have exhibited renewed interest in watershed based planning and assessment of their activities. States are ultimately responsible for upgrading water quality. To that end, 39 states have created purely voluntary programs for reducing nonpoint source pollution from agriculture. Congress is again considering revisions in the Federal Water Pollution Control Act. Voluntary programs face formidable obstacles. Regulatory programs can better pinpoint abatement efforts and motivate action where cooperation is not volunteered. A mixture of assistance and mandatory provisions, like those now used in 11 states, seems to address policy most effectively. (Baker-IVI)
W85-05942

POLICIES FOR NONPOINT-SOURCE WATER POLLUTION CONTROL,
Resources for the Future, Inc., Washington, DC. Quality of the Environment Div.
W. Harrington, A. J. Krupnick, and H. M. Peskin.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 27-32, January-February, 1985. 3 Fig, 17 Ref.

Descriptors: *Policy, *Water pollution control, *Nonpoint source pollution, Water quality control, Decision making, Political aspects.

Point source water pollution controls alone are insufficient to meet the objectives of the Clean Water Act. The failure of existing policies to reduce nonpoint pollution, together with the inability of point-source control policies alone to achieve water quality objectives has rekindled interest in workable nonpoint-source control policies. The policy options for nonpoint source pollution control include volunteerism, command and control policies, economic incentives, adjustment of other government policies, and cross-compliance with other federal programs. Governmental responsibilities for implementing pollution control policies are briefly considered along with a means for selecting a policy approach. (Baker-IVI)
W85-05943

PAYING THE NONPOINT POLLUTION CONTROL BILL,
Michigan State Univ., East Lansing. Dept. of Agricultural Economics.
L. W. Libby.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 33-36, January-February, 1985. 2 Fig, 8 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Economic aspects, Farming, Erosion, Runoff, Political aspects.

Agricultural nonpoint pollution happens because of what farmers and other users do or fail to do on the land. The first step in discussing the distribution of costs for nonpoint pollution control requires identifying key people involved. First, those whose actions inadvertently cause nonpoint pollution such as the farmers when erosion and runoff from farms is the cause. A second category of interested parties include those whose livelihood depends on farmers including the agricultural business at both the input and output ends of farm production. Third are groups and individuals currently bearing the impacts of nonpoint pollution. A fourth category are those paid to care about nonpoint pollution - officials of federal, state, and local governments. Achieving a satisfactory reduction in nonpoint pollution will cost money with the amount depending on the method taken. Alternative approaches include the benefits-received approach, the ability-to-pay approach, and mandatory soil conservation measures. In the future there must be greater coherence among the national and local governmental agencies involved. (Baker-IVI)
W85-05944

STATE INITIATIVES IN NONPOINT-SOURCE POLLUTION CONTROL,
Association of State and Interstate Water Pollution Control Administrators, Washington, DC.
R. Savage.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 53-54, January-February, 1985. 1 Fig, 1 Tab.

Descriptors: *Nonpoint pollution sources, *Water pollution control, Planning, Mining, Management, Agriculture, Water quality, Water pollution sources, Regulation.

The Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) represents the interests of state, interstate, and territorial officials who administer water quality programs. This group recently investigated water quality progress over the 10 year period from 1972 to 1982. The need was identified for more comprehensive evaluation of nonpoint-source pollution problems and more aggressive implementation of control programs. A nonpoint source pollution survey was initiated to further define needs and methods for evaluating the impacts of nonpoint source pollution. Nearly all the states responded that they use of mix of federal, state and local programs to address nonpoint source pollution problems. Most states use both voluntary and regulatory programs for mining, construction, and urban nonpoint sources, while virtually all states rely on the educational/voluntary approach for agricultural sources. (Baker-IVI)
W85-05946

NONPOINT POLLUTION CONTROL: THE WISCONSIN EXPERIENCE,
Wisconsin Dept. of Natural Resources, Madison. Nonpoint Source and Land Management Section.
J. G. Konrad, J. S. Baumann, and S. E. Bergquist.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 55-61, January-February, 1985. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Wisconsin, Planning, Decision making, Management, Water quality,.

Three premises undergird the Wisconsin program. First, because pollutants can originate from many different nonpoint sources, effective controls must be comprehensive. Second, because of the comprehensive nature of the Wisconsin nonpoint-source control program, the goals of soil conservation programs are not the same as the state's water quality goals. Third, a nonpoint-source pollution control program is, by definition, a water quality program. Six years of program experience have shown that the successful blend of many agencies and units of government results in a comprehensive program that assures the achievement of nonpoint-source pollution control objectives. Major program objectives are to identify the most effective approach for achieving specific water quality objectives and to provide adequate financial and technical assistance to landowners and operators for the installation of approved nonpoint source control practices; to provide coordination between nonpoint source pollution control efforts and other elements of the state's water quality program; and to focus limited technical and financial resources in critical geographic areas. Six criteria were used to determine which watershed projects must receive priority management concern: the severity of water quality problems, the magnitude of the pollutant load likely causing the pollution and the potential to reduce that load significantly; landowners' willingness to participate in the program; the willingness and capability of local agencies to carry out their role in the program; the willingness and capability of local agencies and units of government to control other sources of pollution; and the potential public use and benefits that will result from the proposed watershed project. (Baker-IVI)
W85-05947

CONSERVATION DISTRICT ROLE IN NONPOINT POLLUTION CONTROL,
National Association of Conservation Districts, Washington, DC.
M. M. Garner, and R. E. Williams.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 62-64, January-February, 1985. 1 Fig, 5 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Conservation districts, Water quality control, Management, Decision making.

The essential elements of successful water quality management programs are obvious - research, information and education, technical assistance, cost-sharing, and often a regulatory authority for unusual problems. Conservation districts have neither the expertise nor the resources to be self-sufficient. What they do have is broad authority to plan and carry out programs for soil and water conservation. In a growing number of states, this authority includes responsibility for certain aspects of water quality. These additional responsibilities make close cooperation and mutual effort with water quality management agencies mandatory. Districts realize that with the advent of water quality as a national concern they are dependent on other than traditional soil conservation agencies for expertise and cooperation. Conservation districts create interest, organize efforts, and achieve harmonious coordination of multiple agency involvement in the solution of nonpoint source pollution problems. If nonpoint source pollution problems are to be controlled effectively, conservation districts must reach out to all agencies and organizations that can contribute expertise, resources and time for cooperative efforts. Their ability to do this will determine, in large measure, not only their own effectiveness but the success of local people in achieving natural resource conservation. (Baker-IVI)
W85-05948

SETTING AGRICULTURAL POLLUTION CONTROL PRIORITIES,
Idaho Soil Conservation Commission, Boise.
L. L. Holstine, and S. M. Lowman.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 65-67, January-February, 1985. 1 Fig, 1 Tab.

Descriptors: *Water pollution control, *Agriculture, *Priorities, *Idaho, Soil erosion, Watersheds, Grazing, Cost-sharing, Public participation.

An important part of the program for pollution control in Idaho has revolved around the setting of priorities. Emphasis was put on concentrating efforts in those areas with severe impacts from farming and grazing activities. The commission contacted the 51 conservation districts in the state, asking each to identify soil erosion problems. This compilation of identified erosion problems and affected stream segments was then circulated for public review and input. Meetings were held to involve local people familiar with the land and water in question. After evaluating and incorporating the changes from the public input the division and commission analyzed whether the impact of

agricultural activities was severe, moderate, or slight, based on the division's segment priority list. To date nine projects have been funded in high priority watersheds. The process used to set priorities for the state cost-sharing program involved the same agencies, but it also involved a specific rating system. Potential projects identified as a public health emergency need no further rating as this section has the highest number of points possible for priority setting. (Baker-IVI)
W85-05949

SELECTING CRITICAL AREAS FOR NONPOINT-SOURCE POLLUTION CONTROL,
North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering.
R. P. Maas, M. D. Smolen, and S. A. Dressing.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 68-71, January-February, 1985. 2 Fig, 1 Tab, 9 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, Agriculture, Soil erosion, Water pollution sources, Fertilizers, Animal wastes, Conservation.

Guidelines for selecting critical areas for nonpoint source pollution control can be established with the help of what is currently known about pollutant transport processes. There are two distinct critical area perspectives: the land resource perspective and the water resource perspective. Although each specific pollution control project probably requires somewhat unique appropriate criteria, guidelines can be established for most situations. Attention must be given to the type of water resource impairment, erosion rate, manure sources, fertilizer rates and timing, pathogen source magnitude, distance to nearest watercourse, distance to impaired water resource, present conservation status, planning time frame, designated high priority subbasin, and on-site evaluation. (Baker-IVI)
W85-05950

URBAN SEDIMENT AND STORMWATER CONTROL: THE MARYLAND EXPERIENCE,
Maryland Water Resources Administration, Annapolis.
For primary bibliographic entry see Field 4D.
W85-05951

SUCCESSFUL WATER QUALITY PLANNING: AN AREAWIDE PERSPECTIVE,
Southern California Association of Governments, Los Angeles. Water Quality and Waste Management Program.
M. K. Gensemer, and M. Yamaguchi.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 76-78, January-February, 1985. 2 Fig.

Descriptors: *Water quality control, *Planning, *California, Nonpoint pollution sources, Water pollution control, Management, Public participation.

In 1976 the California State Water Resources Control Board designated the Southern California Association of Governments as the area wide waste treatment management planning agency for the South Coast planning area. The 208 plan investigated water quality problems and identified waste management needs throughout the 208 planning region. It resulted in 10 plan element reports and 22 plan element appendices. The various 208 continuing planning projects in the South Coast region ranged from moderately to highly successful. Two major projects are reviewed, the Upper Newport Bay Watershed - San Diego Creek Comprehensive Stormwater Sedimentation Control Plan; and the San Fernando Valley Basin plan. Some factors that can be identified as furthering the objective of implementing nonpoint-source pollution control planning projects include: emphasis on implementation in the initial project conception; local endorsement of the planning process from the time of project initiation and dedication to seeing the problem resolved; formation of oversight, technical, and/or executive committees made up of the various interested parties to assume shared planning and implementation responsibilities; a regional agency acting as mediator between local governments and between local and state authorities; and public participation that emphasizes promoting problem solutions rather than merely disseminating information. (Baker-IVI)
W85-05952

SAVING THE CHESAPEAKE: MARYLAND'S AGRICULTURAL EDUCATION PROGRAM,
Maryland Univ., College Park. Dept. of Agronomy.
W. L. Magette, R. A. Weismiller, and K. C. Gugulis.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 79-81, January-February, 1985.

Descriptors: *Agriculture, *Education, *Chesapeake Bay, *Maryland, Public relations, Water pollution control, Estuaries, Public information.

A multimillion dollar study completed in 1983 identified the major sources of pollution to the Chesapeake Bay, among them being agriculture. The Bay is the nation's largest estuary. Research has indicated that large quantities of nutrients were entering the bay, causing increasing numbers of algal blooms which depressed the oxygen levels and inhibited sunlight penetration to aquatic vegetation. A massive educational strategy was developed for helping to deal with the problem, including theme selection and logo development, promotional items, a campaign kickoff, newspaper articles, radio releases, television releases, generation of fact sheets, slide programs, state fair exhibit, and an information kit. This program was aimed particularly at the agricultural industry and entitled Maryland Farmers: Partners with the Bay Campaign. While the campaign is only 6 months old, progress to date looks encouraging, and the future of the campaign seems good. (Baker-IVI)
W85-05953

ORGANIZING AN INFORMATION PROGRAM FOR NONPOINT POLLUTION CONTROL,
Eau Claire, WI.
D. D. Sorenson.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 82-83, January-February, 1985.

Descriptors: *Nonpoint pollution sources, *Wisconsin, *Public participation, Education, Planning, Water pollution control, Agricultural watersheds.

While there is a wealth of experience about the role of information in adoption of individual farm practices, much less is known about how an information program encourages adoption of best management practices in targeted watersheds to accomplish specific water quality objectives. Wisconsin's legislature in 1978 created the Nonpoint Souce Water Pollution Abatement Program under which four or five new watersheds are selected annually until a total of about 125 are funded for nonpoint source pollution abatement work. As of 1984 26 watersheds were in the program. Among the specific elements of a good program are detailed identification of the audience and project objectives, planned financing and staffing, a long-range schedule of activities, interagency coordination, creating public awareness, motivating people to action and convincing them to change their land management activities. In a survey designed to evaluate the program thus far, two main ponts were identified: start an intensive education effort early in the project and get more assistance from the state extension staff. (Baker-IVI)
W85-05954

BELGRAVE CREEK: A SUCCESSFUL NONPOINT POLLUTION CONTROL PROJECT IN RURAL ONTARIO,
Credit Valley Conservation Authority, Meadowvale (Ontario).
M. Puddister.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 84-86, January-February, 1985. 2 Fig, 1 Tab, 7 Ref.

Descriptors: *Belgrave Creek, *Ontario, *Nonpoint pollution sources, *Erosion control, Fish habitats, Cattle, Fences, Planning, Management, Watersheds, Water pollution control.

The Belgrave Creek subbasin is located in the western portion of the Maitland River watershed, 20 miles from Lake Huron. Land uses are primarily agricultural with about 41% in pasture, 33% in cultivation, 21% forested and about 3% of the subbasin is in minor urbanized areas. Cattle access to the creek appeared to be the major cause of erosion, so remedial works were begun to focus primarily on this problem. Barbed wire fencing, properly constructed access points and other alternatives for watering and reforestation along the creekbank were the major solutions. Landowner cooperation was high. A high degree of interagency cooperation was also achieved. Fish surveys showed a significant rise in fish population. Several key principles attributing the success of the project include a detailed background inventory, site prioritization, landowner cooperation, interagency cooperation, adequate funding, clearly defined program administration, effective program evaluation, communication of results, and post project monitoring. (Baker-IVI)
W85-05955

MANAGING RIPARIAN ECOSYSTEMS TO CONTROL NONPOINT POLLUTION,
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
R. Lowrance, R. Leonard, and J. Sheridan.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 87-91, January-February, 1985. 4 Fig, 37 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Riparian land, Wetlands, Conservation, Riparian vegetation, Nutrients, Sediments, Management.

Riparian ecosystems are complex assemblages of organisms and their environment existing adjacent to and near flowing water. They have two essential characteristics: laterally flowing water that rises and falls at least once within a growing season, and a high degree of connectedness with other ecosystems. The effects of riparian wetlands on nonpoint source pollution hinge largely on how riparian zone hydrology affects watershed response. Freshwater wetlands can filter out nutrients and improve water quality. If riparian wetlands exist in agricultural watersheds where upland fields are heavily fertilized, nutrient filtering in streamside areas can help control agricultural nonpoint-source pollution. Riparian zone factors that affect nutrient outputs include physical, vegetative, and soil processes. A case study was conducted on the Little River watershed near Tifton, Georgia where the internal nutrient cycling dynamics of the riparian forest ecosystem was quantified and sediment delivery ratios were developed to estimate nutrient and sediment deposition in the riparian ecosystem. Management options for riparian ecosystems range from strict preservation of the forest ecosystem to complete removal of the native vegetation and alteration of hydrologic conditions. Future management policies for riparian ecosystems should recognize inherent and man-made regional differences. (Baker-IVI)
W85-05956

NONPOINT POLLUTION CONTROL ON PUBLIC LANDS,
Bureau of Land Management, Lakewood, CO. Denver Service Center.
B. P. Van Haveren, E. B. Janes, and W. L. Jackson.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 92-94, January-February, 1985. 3 Fig, 16 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Public lands, Land management, Grazing, Riparian land, Forest management, Water quality, Land use.

The Bureau of Land Management meets its water quality responsibilities various ways: water quality improvement objectives are integrated into landuse plans; funding for soil and water programs is used mainly for project level activities; and watershed rehabilitation projects, many of which include nonpoint source water pollution control objectives, are implemented throughout the western United States. Additional resource management strategies, including improved livestock grazing systems, intensive riparian area management, and good forest management practices, all contribute indirectly to improved water quality. Continued resource monitoring assures that water quality management ojectives are being achieved. (Baker-IVI)
W85-05957

COLIFORMS AS AN INDICATOR OF WATER QUALITY IN WILDLAND STREAMS,
Malheur National Forest, John Day, OR.
For primary bibliographic entry see Field 5A.
W85-05958

LOGGING AND WATER QUALITY; STATE REGULATION IN NEW ENGLAND,
Maine State Planning Office, Augusta.
L. C. Irland.
Journal of Soil and Water Conservation, Vol. 40, No.1, p 98-102, January-February, 1985. 3 Fig, 2 Tab, 52 Ref.

Descriptors: *Logging, *Forest management, *Water quality, Land use, Regulations, Management, Watershed protection, Water pollution control, Nonpoint pollution sources.

Timber harvesting and associated roadbuilding can affect water quality in New England. Because affected streams are important for water supply and fisheries and because the waters are state property, there is basis for public policy concern. Maine, Connecticut, Massachusetts, and Vermont employ contrasting strategies. Maine regulates logging and major haul roads by standards and permits in selected areas. Connecticut has no state program, but some towns are regulating logging. Massachusetts recently established a statewide, advance permit requirement for all operations above a minimum size. And Vermont has established an innovative cooperative program designed to mitigate sedimentation through cooperation with a loggers' organization. These programs labor under several difficulties: landowner and logger resistance; lack of adequate enforcement resources; an inadequate base of technical knowledge about logging effects, fishery impacts of sedimentation, and the effectiveness of prescribed mitigating measures. The states have made only minimal staff committments to education and enforcement. At present there is no basis for saying which approach is superior. A top priority should be additional field research on effective sediment control practices and their costs, on the impacts of sedimentation or fisheries, and on low impact logging machinery and systems. (Baker-IVI)
W85-05959

COST-EFFECTIVE TARGETING OF AGRICULTURAL NONPOINT-SOURCE POLLUTION CONTROLS,
Tennessee Valley Authority, Knoxville. Environmental Quality Staff.
A. M. Duda, and R. J. Johnson.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 108-111, January-February, 1985. 2 Fig, 19 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Agriculture, *Cost analysis, Economic aspects, Water quality, Policy, Soil conservation, Agricultural watersheds.

Investigations conducted under the Clean Water Act and the Soil and Water Resources Conservation Act found agriculture to be the most significant contributor of nonpoint source pollutants to the nation's waters. Interagency, cooperative programs must be targeted to pollution hot spots in watersheds with priority water quality problems if Clean Water Act goals are to be attained. Not only is the problem of concern in so far as water quality and environmental impact go, but the failure to use best management practices on agricultural land also causes an appreciable drain on the nation's economy. In the 1960s hydrologic research conducted by the Tennessee Valley Authority on agricultural watersheds in western North Carolina yielded important information on the effectiveness of soil conservation practices and on the source of runoff and pollution from agricultural land. Specific areas where work was needed were isolated. There are four basic policy options for targeting agricultural water quality management programs to pollution hot spots: continuing the existing voluntary/educational programs, expanding cost-sharing/educational efforts, using a system of incentives and disincentives (including cross-compliance), and a national regulatory program for implementation of agricultural BMPs. (Baker-IVI)
W85-05960

AGRICULTURAL NONPOINT POLLUTION CONTROL: VOLUNTARY OR MANDATORY,
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
D. J. Epp, and J. S. Shortle.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 111-114, January-February, 1985. 8 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Agriculture, Conservation, Regulations, Management, Soil conservation.

Efforts to accelerate the adoption of soil conservation practices will come by moving from voluntary to mandatory implementation of regulations. Mandatory pollution control programs can take a number of forms. One alternative is to require a specific technique for achieving the desired abatement, for example, requiring the use of specified erosion control practices to reduce sediment delivery. To be efficient in achieving national goals for nonpoint pollution abatement, a mandatory program for agriculture must focus on the social value of damages caused by the pollution and consider the costs of the program to agricultural producers and governmental units that administer the program. A socially efficient abatement program has two key features: the program distributes costs of water quality improvements among pollutant sources in a manner that minimizes society's costs, and it strikes an appropriate balance between society's abatement costs and the social benefits of abatement. An efficient nonpoint pollution abatement program for agriculture must focus on what to plant and how to plant rather than on measuring actual discharges of pollutants into a waterway. The only practical solution is to develop accurate models of pollution from various cropping practices by soil type, slope, climate, and proximity to waterways. (Baker-IVI)
W85-05961

SOIL LOSS REDUCTION IN FINLEY CREEK, INDIANA: AN ECONOMIC ANALYSIS OF ALTERNATIVE POLICIES,
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
J. G. Lee, S. B. Lovejoy, and D. B. Beasley.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 132-135, January-February, 1985. 4 Fig, 1 Tab, 7 Ref.

Descriptors: *Soil conservation, *Erosion control, *Finley Creek, *Indiana, *Economic aspects, Crop production, Tillage, Public policy, Subsidies, Costs, Soil erosion.

One policy proposed to reduce agricultural sediment yields is the targeting of federal resources to areas with high soil loss rates. There is a need to evaluate the physical and economic impacts of targeting policies at the local level. The Finley Creek watershed is fairly representative of farming operations and cropping patterns in central Indiana. A survey was conducted of 15 owner/operators in the Finley Creek watershed to determine: current production practices; attitudes towards soil conservation practices and policies designed to reduce sedimentation from cropland; cropping patterns and tillage practices; and willingness to change cropping patterns and tillage practices, and the subsidy required to make a voluntary change. Alternative policies analyzed include: nontargeted minimum tillage; targeted minimum tillage; and targeted conversion. Of the three alternative policies, the targeted minimum tillage subsidy program appears to be the most cost-effective means of reducing sediment for various levels of participation rates and discount rates greater than 4%. While the efficiency of a microtargeting program may seem obvious, the difference in costs of targeting versus nontargeting may be as large as 5 to 10 times. (Moore-IVI)
W85-05963

ACCELERATED IMPLEMENTATION PROGRAM FOR REDUCING THE DIFFUSE-SOURCE PHOSPHORUS LOAD TO LAKE ERIE,
Ohio State Univ., Columbus. Dept. of Agronomy.
D. L. Forster, T. J. Logan, S. M. Yaksich, and J. R. Adams.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 136-141, January-February, 1985. 4 Fig, 8 Tab, 9 Ref.

Descriptors: *Erosion control, *Phosphorus, *Conservation tillage, *Lake Erie Basin, Agricultural runoff, Water pollution control, Economic aspects, Soil erosion, Fertilizers.

The U.S. Army Corps of Engineers Lake Erie Wastewater Management Study (LEWMS) identified P as the nutrient most affecting the extent of eutrophication in Lake Erie, and showed that the rural, primarily agricultural, diffuse P load needed to be reduced by about 26% to reduce eutrophication significantly. Accelerated implementation of conservation tillage, including no-till, on soils suited to these practices on the U.S. side of the Lake Erie Basin can achieve the required reduction in the diffuse P load. Based on economic analyses, widespread adoption of conservation tillage on suitable soils and better fertilization management practices will not be detrimental to net farm income; practices should improve net income if recommended management practices are followed. Under the existing management program, farmers would employ conservation tillage practices on 59% of Lake Erie Basin cropland by the year 2002. The accelerated program proposed would increase that adoption rate to 76%. The 1982 basinwide cropland erosion rate is 16.3 million t/yr. Under the accelerated program, erosion ultimately will decline to 8.5 million t/yr. Between 1982 and 2002, total P loadings to Lake Erie in the U.S., with the accelerated conservation tillage program, would be reduced by 33,000 tons, compared to 12,600 tons under the existing program. (Moore-IVI)
W85-05964

BEST MANAGEMENT PRACTICES FOR CONTROLLING NONPOINT-SOURCE POLLUTION ON FORESTED WATERSHEDS,
Pennsylvania State Univ., University Park.
J. A. Lynch, E. S. Corbett, and K. Mussallem.
Journal of Soil and Water Conservation, Vol. 40, No. 1, p 164-167, January-February, 1985. 4 Fig, 2 Tab, 11 Ref.

Descriptors: *Watershed management, *Water pollution control, *Forest management, *Nonpoint pollution sources, Roads, Logging, Forest watersheds, Clear-cutting.

Controlling nonpoint-source pollution during and following silvicultural activities is an essential part of any sound forest management plan. A set of best management practices (BMPs) was developed by the Pennsylvania Department of Environmental Resources, Bureau of Forestry, to limit and/or control nonpoint-source pollution. Among the BMPs used are the following: protective buffer strips; a prohibition on skidding over streams; supervision of logging by a qualified forester; division of timber sales into blocks with cutting restricted to one block at a time; no disposal of tops or slash within 8 m of streams; proper location of haul roads, skid trails and log landings; retirement

of skid trails, haul roads and culverts after logging; posting of a performance bond prior to logging. A watershed study conducted in central Pennsylvania suggested that the BMPs were effective in controlling nonpoint-source pollution from a 44.5-hectare commercial clearcut. Slight increases in stream temperature, turbidity, and nitrate and potassium concentrations were observed, but these increases did not exceed drinking water standards. The increases in temperature and nutrients were possibly temporarily beneficial to the aquatic ecosystem. (Moore-IVI)
W85-05971

ZURICH FASTIDIOUS ABOUT ITS WATER.
Engineering News Record, Vol. 214, No. 12, p 108 and 111, March 21, 1985. 3 Fig.

Descriptors: *Water supply development, *Zurich, *Switzerland, Groundwater, Drinking water, Water quality control.

Zurich's Hardhof complex was carefully designed to protect the quality of drinking water for the city. Making use of buried water resources was another of the goals. The system is able to protect water supplies in the event of natural disaster, sabotage or war. The site itself is landscaped such that there are 62 acres of space, laid out with open fields, shrub-covered mounds and newly planted trees. Underneath, pumps gather as much as 40 million gallons of groundwater per day and dispatch it to consumers throughout the city. Details of the construction are provided. (Baker-IVI)
W85-05978

GROUNDWATER PROTECTION: A CONTRAST IN STATE STYLE,
Kellogg Corp., Littleton, CO.
J. L. Moorhouse.
Water Engineering and Management, Vol. 132, No. 3, p 23-25, March, 1985. 1 Tab, 1 Ref.

Descriptors: *Groundwater management, *Water pollution control, *New Mexico, *Connecticut, Regulations, Water quality control, Groundwater pollution, Land use.

A review was made of the groundwater quality protection programs of New Mexico and Connecticut. These states have programs which have been in effect long enough to be evaluated and they represent contrasting approaches to the same problem. New Mexico's program was implemented in February of 1977. The groundwater quality protection program was designed to protect groundwater which has a total dissolved solids value of fewer than 10,000 ppm. Designated groundwater is protected by imposition of numerical standards for 35 pollutants. Seventy-six potentially toxic pollutants are identified, but are not regulated through the use of numerical standards. Rather they are considered toxic if they are present in concentrations which are shown by scientific literature currently available to unreasonably threaten health of plants, animals or humans. A Discharge Plan is the permit used to enforce the New Mexico groundwater quality protection program. Connecticut's program was implemented in September 1980 and is unique in that it is implemented by the establishment of land use policy. The program is based on the classification of groundwater into four possible classes. A nondegradation approach is used for three of the classes. An extensive hydrogeologic, geographic, biological, and land use data collection program was completed in order to classify Connecticut's groundwater. The system establishes water quality goals and general criteria limits but does not control actual discharges. These are controlled through administration of the Connecticut Discharge Permit, which existed prior to the groundwater classification program. (Baker-IVI)
W85-05979

PROGRESS IN MUNICIPAL PHOSPHORUS CONTROL,
Windsor Univ. (Ontario). Great Lakes Inst.
J. H. Hartig.
Water Engineering and Management, Vol. 132, No. 3, p 32-33, March, 1985. 1 Fig, 7 Ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Michigan, Municipal wastes, Eutrophication, Phosphorus, Nutrients, Detergents, Combined sewer overflows.

One major initiative adopted in Michigan attempts to meet requirements of the Clean Water Act of 1972 was a 1 mg/l effluent total phosphorus standard for all municipal wastewater treatment plants with design flow capacities greater than or equal to 1 mgd. Phosphorus removal is practiced at most municipal treatment facilities in Michigan, 79 of the 93 surveyed have such treatment systems. Of these 79, 65 use an iron salt, 11 an aluminum salt, and 3 use lime. In the mid 1970s a survey indicated that 39% of the major plants with phosphorus removal were achieving effluent total phosphorus concentrations of less than or equal to 1 mg/l. One effective component of Michigan's phosphorus management program to control cultural eutrophication has been its phosphorus detergent ban which limits the elemental phosphorus content of household laundery detergents to 0.5% by weight. Combined sewer overflows in many of Michigan's large urban areas continue to be a source of phosphorus discharges to surface waters. During wet weather a portion of the combined storm and sanitary flow that exceeds interceptor or treatment plant capacities is discharged directly to receiving water bodies. (Baker-IVI)
W85-05981

DEMANDS PLACED ON PROCESSING PLANTS BY DEVELOPMENTS IN LEGISLATION FOR THE PROTECTION OF WATER (ANFORDERUNGEN AN VERFAHRENSTECHNISCHE ANLAGEN DURCH DIE WEITERENTWICKLUNG DER GEWASSERSCHUTZ-VORSCHRIFTEN),
Hoechst A.G., Frankfurt-am-Main (Germany, F.R.).
For primary bibliographic entry see Field 6E.
W85-05982

ECOLOGICAL ASPECTS OF THE DESIGN AND OPERATION OF CONDUITS OF HYDROELECTRIC SCHEMES,
S. I. Egorshin, N. A. Ivanov, S. N. Lozhkin, L. M. Mikots, and V. M. Semenkov.
Hydrotechnical Construction, Vol. 18, No. 6, p 254-259, June, 1984. 5 Fig, 11 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 16-20, June, 1984.

Descriptors: *Dam design, *Hydroelectric plants, *Intakes, *Ecological effects, Stratification, Eutrophication, Reservoir operation, Thermal storage, Reservoir releases, Water quality control.

This paper reviews the influence of stratification on the physical, chemical, and biological properties of water stored in large reservoirs. These include effects on blooms of algae, particularly the bluegreens, and on the storage of heat in the reservoir. In order to prevent negative ecological consequence, it is recommend that reservoirs be designed with multilevel service intakes making it possible to regulate the thermal, hydrochemical, and hydrobiological regimes in the upper and lower pools. The principal of withdrawal of water from various layers can become the basis for creating an automated water-quality management system of the reservoir and the lower pool. (Keenan-IVI)
W85-05986

SOME ECOLOGICAL EFFECTS OF ARTIFICIAL CIRCULATION ON THE PHYTOPLANKTON,
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Ecology and Freshwater Biology.
M. Rybak.
Hydrobiologia, Vol. 122, No. 1, p 89-96, March, 1985. 2 Fig, 54 Ref.

Descriptors: *Artificial circulation, *Phytoplankton, *Ecological effects, *Lake Mutek, *Poland, Aeration, Destratification, Water circulation, Lake restoration, Mixing, Biomass, Algae.

Studies were carried out in Lake Mutek (Mazurian Lakeland, Poland) on the effect of artificial destratification induced by direct aeration, upon quantitative changes in the phytoplankton from 1977 until 1983. Two different methods of aeration were used. Low intensity mixing resulted in 1978 in a two-fold, and in 1979 in a four-fold increase of the phytoplankton biomass, in relation to the control year 1977. Increase of phytoplankton biomass during lake aeration was due to the development of Ceratium hirudinella. Use of a highly effective air-compressor in 1981-1983 caused an inhibition of algal development, so that biomass dropped to levels noted in the control year. The effect of aeration depended on the ratio between lake area and effectiveness of the aerator. Only intensive mixing of the water masses resulted in an inhibition of the development of algae. Water mixing caused translocation of the algae to the abiotic zone, and this affected significantly the utilization of light by the algae. The effect of artificial destratification was also reflected in changes of the species structure, seasonal succession of the algae, and physiological state of the phytoplankton. Artificial circulation stimulated development of algae characterized by relatively high specific weight, i.e. Pyrrophyta, Bacillariophyceae and some species of Chlorophyta. (Moore-IVI)
W85-06009

DETERMINISTIC LINEAR PROGRAMMING MODEL FOR ACID RAIN ABATEMENT,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
J. H. Ellis, E. A. McBean, and G. J. Farquhar.
Journal of Environmental Engineering, Vol. 111, No. 2, p 119-139, April, 1985. 5 Fig, 10 Tab, 18 Ref.

Descriptors: *Water pollution control, *Acid rain, *Linear programming, *Mathematical models, Air pollution, Decision-making, Sulfur dioxide, Economic aspects.

The development of acid rain abatement strategies must deal with large land masses and contend with international complications, due to the nature of atmospheric pollutant transport. A deterministic Linear Programming (LP) model is presented for development of acid rain abatement strategies in eastern North America. Pollutant (SO2) sources are categorized as either controllable or noncontrolled, (i.e., area sources). The model determines the least-cost set of SO2 removal levels at each of the 235 largest point sources in eastern North America, such that stipulated maximum wet surface deposition rates are not exceeded at 20 predetermined sensitive receptor locations. The LP model consists of an objective function and a set of linear constaint equations. The objective function measures the monetary expenditure arising from pollutant removal across all sources. The model is flexible with respect to input data requirements and is able to conveniently and efficiently accommodate varying constraint formulations. Model applications are presented which involve five different constraint formulations. A relatively large and complex modeling exercise can be summarized, using the LP model and accumpanying interpretation routines, into a concise, comprehensive and understandable form for use by decision-makers. (Moore-IVI)
W85-06017

1-D POLLUTANT MIGRATION IN SOILS OF FINITE DEPTH,
University of Western Ontario, London. Faculty of Engineering Science.
For primary bibliographic entry see Field 5B.
W85-06024

CONTROLLING ACIDIC-TOXIC METAL LEACHATES FROM SOUTHERN APPALACHIAN CONSTRUCTION SLOPES: MITIGATING STREAM DAMAGE,
E. L. Morgan, W. F. Porak, and J. A. Arway.

Transportation Research Record, Vol. 948, p 10-16, 1984. 3 Tab, 23 Ref.

Descriptors: *Construction, *Appalachian Mountains, *Metals, *Leachates, Drainage, Streams, Toxicity, Acidity, Water pollution control, Pyrites, Tellico-Robbinsville Highway, Tennessee, North Carolina.

The scenic Tellico-Robbinsville Highway traverses ridges and peaks of the southern Appalachian Mountains from Tellico Plains, Tennessee, to Santeetlah Gap in North Carolina. Highway construction activities exposed geological formations that contain pyritic materials, and drainage from slope and fill caused considerable change in streams that receive these toxic leachates. These drainages which mobilize high levels of free acidity and various toxic metals have destroyed aquatic ecological systems in reaches of mountain streams. Mitigation procedures were initiated in 1977 in the North River drainage of the Tellico River to seal exposed Anakeesta road fill of the Tellico-Robbinsville Highway with soil blankets and temporary sodium hydroxide neutralization. The effectiveness of this treatment has been evaluated. Mitigated streams showed a general improvement in physicochemical water quality during the period when NaOH neutralization measures were used. After the completion of more permanent surface sealing of road embankments and the subsequent termination of sodium hydroxide treatments, the physicochemical water quality of mitigated streams degraded in comparison with that of reference streams. (Baker-IVI)
W85-06064

WATER RESOURCES DEVELOPMENT AND MANAGEMENT PLANS, PART VIII: WATER-QUALITY CONTROL MODELS - AN ASPECT OF THE WATER-QUALITY MANAGEMENT STUDY 'BEWIRTSCHAFTUNGSPLAN LEINE' (BEWIRTSCHAFTUNGSPLANE, TEIL VIII: ENTSCHEIDUNGSMODELLE IN DER WASSERGUTEWIRTSCHAFT - EIN TEILASPEKT DER PILOTSTUDIE BEWIRTSCHAFTUNGSPLAN LEINE),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
R. G. Cembrowicz.
Deutsche Gewasserkundliche Mitteilungen, Vol. 28, No. 5/6, p 146-158, December, 1984. 10 Fig, 29 Ref.

Descriptors: *Model studies, *Water quality management, *Water pollution control, *Water management, Water use, Computer models, Economic aspects, Wastewater treatment, Canals, Planning.

Control models devised or employed in the Leine Pilot Project were designed with the purpose of implementing planning objectives employing public means most economically. The models were developed as computer programs based upon Operations Research algorithms, incorporating water quality and economic considerations. Their general concept allows for the use of a model in any river basin. Modeling approaches have proved superior to planning methods used in practices. Computations were performed using three control models. The first assumes the perspective of a river basin authority; optimal measures, costs and benefits related to specific quality standards are determined for a given basin. In a second version the results are compared to the optimal waste discharge strategy of individual discharge control, subject to effluent charges and treatment costs. The third model deals with the optimal regional allocation of wastewater treatment plants; large ones offer economies of scale but necessitate transportation canals which may be omitted for smaller plants at the expense of cost degression. The optimal sizing and allocation of the treatment plants determined with the aid of the model is laid down in the State Waste Water Disposal Plan. (Baker-IVI)
W85-06156

WATER QUALITY VARIATIONS AND CONTROL TECHNOLOGY OF YAMUNA RIVER,
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W85-06171

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

OPTIMAL EXPANSION OF WATER DISTRIBUTION SYSTEMS,
Visvesvaraya Regional Coll. of Engineering, Nagpur (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W85-06020

IRRIGATION SYSTEM STUDY IN INTERNATIONAL BASIN,
Indian Inst. of Tech., New Delhi. Dept. of Applied Mechanics.
M. C. Chaturvedi, and U. C. Chaube.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 137-148, April, 1985. 4 Fig, 1 Tab, 4 Ref, 1 Append.

Descriptors: *Irrigation systems, *International basins, *Ganga Basin, *India, *Bangladesh, Regional development, Water resources development, Model studies, Developing countries, Water conservation, Conjunctive use, Artificial recharge, Water demand.

Before taking up a comprehensive study of regional irrigation development, it is necessary to identify and understand the technological options, the physical process and the allocation of water resources to pertinent projects. Linear programming models have been used for such a reconnaissance study of the Indo-Nepal region of the Ganga basin with boundary conditions by Bangladesh. The region is a very large system in terms of resources' potential, developmental options and associated constraints. The irrigation model study is carried out at the sub-basin level (Level I) and at the basin level (Level II). The issues analyzed at level I are: (1) Implications of scale of project developments, (2) implications of resource conservation measures such as reducing seepage and evaporation losses and improving irrigation efficiency, (3) implications of conjunctive surface water, natural recharge and artificial recharge use, and (4) implications of crop water demand. At level II the issue is the implication of water demand at Ferakke (by India and Bangladesh). The study identifies the operating constraints and relative impact of various issues and options on the irrigation development in physical terms. (Author's abstract)
W85-06027

CAPACITY EXPANSION OF SAO PAULO WATER SUPPLY,
Sao Paulo Univ. (Brazil). Dept. de Hidraulica.
B. P. F. Braga, Jr., J. G. L. Conejo, L. Becker, and W. W.-G. Yeh.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 238-252, April, 1985. 4 Fig, 9 Tab, 22 Ref, 1 Append.

Descriptors: *Water resources development, *Water supply, *Planning, *Capacity expansion, *Sao Paulo, *Brazil, Juquia River, Reservoirs, Simulation, Model studies, Pumped storage, Optimization, Water demand, Dynamic programming.

Sao Paulo (Brazil) water requirements are rapidly increasing due to growth in both industry and population, and the current firm water supply must be approximately doubled by the year 2040. Sufficient water is available from the Juquia River system through construction of a network of storage and pondage reservoirs, dams, pumping stations and canals. Much of the natural flow must be pumped back to the distribution point, and at the site of greatest elevation change, a pumped storage plant is contemplated for generation of peaking power as well as pumping for water supply. A capacity expansion model has been developed to facilitate the planning and the optimal timing and sizing of the proposed Juquia River system. A monthly simulation model that utilizes rational operation rules and simulates the optimal operation mode is imbedded in the capacity expansion model so that the optimized results are consistent and hydrologically feasible. Forty-two years of historical streamflows are used in the simulation model. Future water demands up to a time horizon are specified, and a forward dynamic programming algorithm is used to minimize the present worth of total project costs. The proposed Sao Paulo water supply network requires a capacity expansions model that contains a number of complications not generally encountered in the usual capacity expansion applicaton. These complications can be accommodated by relatively simple modifications of model sizing and dynamic programming procedures. (Moore-IVI)
W85-06034

CO-ORDINATED APPROACH TO SMALL HYDRO DEVELOPMENT,
Strafford Regional Planning Commission, Dover, NH.
R. Moldoff.
International Water Power and Dam Construction, Vol. 37, No. 4, p 37-40, April, 1985. 2 Fig, 1 Tab.

Descriptors: *Hydroelectric plants, *Small hydro, *Planning, *Salmon Falls, *Maine, *New Hampshire, Water resources development, Decision making, Management planning, Economic aspects, Environmental effects, Licencing.

A case study is presented of an area where an association of dam owners and hydro developers was formed to promote the coordinated development of small scale hydro plants. Rather than each site being evaluated independently, the entire Salmon Falls river basin in Maine and New Hampshire was studied, the aim being to reduce time delays and increase economic incentives for development. The Salmon Falls approach emphasized the interrelated nature of all potential hydro sites within the Salmon Falls basin. To maximize hydro production, decrease regulatory time lags, and increase economic incentives for development, the approach urged joint completion of hydro projects within the basin. Information sharing, combined permit and licence applications, and joint purchasing of equipment and services were some of the areas of cooperation. A five part plan was approved which included a computerized river flow simulation model, a multi site environmental impact study, a multi site financial analysis, a multi site Federal Energy Regulatory Commission licence application, and a river basin management system which would provide a mechanism for managing water releases from the Milton Three Ponds dam to maximize hydro generation within competing water use constraints. After some initial research, the advantages of a formal association became clear including political leverage, contracting, and resolving conflicts. (Baker-IVI)
W85-06131

6B. Evaluation Process

WATER RESOURCE PLAN PRODUCES MULTIPLE BENEFITS,
Water Services, Redhill (England).
V. French.
Water Engineering and Management, Vol. 132, No. 3, p 28-30, March, 1985. 2 Fig.

Descriptors: *Water resources development, *Water management, *Kielder Dam, *England, Dam construction, Planning, Cost benefit analysis, Hydroelectric plants, Wastewater treatment, Water supply.

The Kielder Dam project will be one of Europe's largest water resource projects and is almost completed. The plan has as its core objective the supply of water for the area's future. Cleverly arranged interchanges of water within the region are initiated on demand, and telemetry links all the components of the system, including wastewater treatment facilities far downstram. Water released from Kielder flows for 36 mi down the North Tyne and the Tyne. At Riding Mill it is abstracted by the Northumbrian Water Authority at one of

Britain's largest pumping stations. Power from the hydroelectric power station is transmitted to Spaeadam in Cumbria where it enters the distribution network. For the first 3 mi it travels by a 33,000 V power transmission line underground. Income derived from the power at Kielder Water will be divided between the CEGB and the Northumbrian Water in proportion to the financial contributions made by the Board and the Authority. The capital cost of the scheme was about $7.5 million and the anticipated income will be in the area of $900,000 at present day prices. (Baker-IVI)
W85-05980

SMALL HYDRO PROGRESS IN MALAYSIA,
National Univ. of Malaysia, Bangi. Faculty of Economics.
U. A. Malik.
International Water Power and Dam Construction, Vol. 37, No. 4, p 25-27, April, 1985. 3 Fig, 1 Tab, 7 Ref.

Descriptors: *Malaysia, *Hydroelectric power, *Small hydro, Pilot plants, Water resources development, Turbines, Economic aspects.

The recent dramatic increase in oil prices has turned interest back to small hydro schemes. More than 120 sites have been identified for mini hydro projects, although, because of a shortage of funds in Malaysia, only a small percentage of these have been developed. Various turbine types have been developed and tested and several have been selected as being particularly suitable for local conditions. Hydrological information, especially rainfall and stream flow characteristics, are important considerations for planning the small schemes. Another major consideration is siltation. Increasing encroachment into catchment areas may increase the silt load at intake points and cause severe damage to the turbines. Economics is the overriding consideration as far as the development of mini hydro in Malasia is concerned. The common approach is to consider the form and capacity of alternative energy sources in terms of economics and practicality. The other options that have been considered are extensions to the existing power grid, and isolated diesel generating stations. Economically the major weakness of a mini hydro project is its relatively high initial capital investment per unit of output. (Baker-IVI)
W85-06129

CO-ORDINATED APPROACH TO SMALL HYDRO DEVELOPMENT,
Strafford Regional Planning Commission, Dover, NH.
For primary bibliographic entry see Field 6A.
W85-06131

WATER RESOURCES DEVELOPMENT AND MANAGEMENT PLANS, PART VIII: WATER-QUALITY CONTROL MODELS - AN ASPECT OF THE WATER-QUALITY MANAGEMENT STUDY 'BEWIRTSCHAFTUNGSPLAN LEINE' (BEWIRTSCHAFTUNGSPLANE, TEIL VIII: ENTSCHEIDUNGSMODELLE IN DER WASSERGUTEWIRTSCHAFT - EIN TEILASPEKT DER PILOTSTUDIE BEWIRTSCHAFTUNGSPLAN LEINE),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
For primary bibliographic entry see Field 5G.
W85-06156

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

PAYING THE NONPOINT POLLUTION CONTROL BILL,
Michigan State Univ., East Lansing. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W85-05944

SUBSIDY AND TAX EFFECTS OF CONTROLLING STREAM SEDIMENTATION IN SOUTH CAROLINA,
Mississippi State Univ., Mississippi State. School of Forestry.
For primary bibliographic entry see Field 4D.
W85-05966

IMPACT OF CONSERVATION ON RATES AND OPERATING COSTS,
Dauphin Consolidated Water Supply Co., Harrisburg, PA.
N. R. Bhatt, and C. A. Cole.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 192-206, April, 1985. 4 Fig, 3 Tab, 24 Ref.

Descriptors: *Water conservation, *Water rates, *Operating costs, *Utilities, Water use, Water storage, Construction costs, Capital costs.

Abrupt water conservation measures often require an increase in unit costs (rates) of water utilities. The potential impact of 20% reduction in water usage through water conservation is investigated for a small investor owned utility serving a rural residential community. The analysis of short-term impact shows that the average bill would be reduced by 16% if rates had not been changed; the company's operating expenses would only have been reduced by 2%. A present worth comparison was made between additional source and storage requirements of the water company throught the year 2020, with and without conservation. Comprehensive and continued 20% water conservation would have postponed source facility and storage facility expansion by 3 and 4 yr, respectively. A 20% reduction in water use would save $71,280 in present worth (1976) for storage and source facilities and operating costs. The savings in capital and operating and maintenance costs would eventually translate into savings in water bills of the customers over the years. Water conservation has definite economic benefits for communities in terms of freeing money for use on other public works, etc. (Moore-IVI)
W85-06031

6D. Water Demand

OPTIMAL OPERATION OF CALIFORNIA AQUEDUCT,
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 4A.
W85-06033

CAPACITY EXPANSION OF SAO PAULO WATER SUPPLY,
Sao Paulo Univ. (Brazil). Dept. de Hidraulica.
For primary bibliographic entry see Field 6A.
W85-06034

6E. Water Law and Institutions

WATER AS AN ARTICLE OF COMMERCE: STATE EMBARGOES SPRING A LEAK UNDER SPORHASE V. NEBRASKA,
Boston Coll., Chestnut Hill, MA.
E. B. Schwartz.
Boston College Environmental Affairs Law Review, Vol. 12, No. 1, p 103-169, 1985. 361 Ref.

Descriptors: *Legal aspects, *Water supply, *Sporhase vs Nebraska, *Commerce Clause, State jurisdiction, Water export, Water rights, Water shortages, Water supply development, Police power.

In July of 1982 the US Supreme Court struck down, in part, a Nebraska statute which greatly limited the right of its citizens to export ground water to another state. This article examines the limitations imposed on state police powers by the commerce clause. The development and nature of state water embargo statutes are reviewed. The Supreme Court's past decisions when faced with a commerce clause challenge to a state water embargo statute are recounted. The Supreme Court's decision in Sporhase is summarized and the likely impact of that decision on state water embargoes and on federal regulation of water is evaluated. Possible arguments in support of removing water embargo statutes entirely from the scope of the commerce clause are examined with focus on the state ownership theory, the argument that water is not an article of commerce, the exceptional police powers argument, the state as market participant exception, and the concept of state sovereignty. While the Supreme Court was correct in finding that there are no available arguments which would entirely exempt water embargo statutes from commerce clause treatment, the commerce clause is a clumsy tool with which to balance the complex, competing federal and state interests in this area. The more appropriate decision might have been to defer to the Congress to resolve this dispute. (Baker-IVI)
W85-05915

POLICIES FOR NONPOINT-SOURCE WATER POLLUTION CONTROL,
Resources for the Future, Inc., Washington, DC. Quality of the Environment Div.
For primary bibliographic entry see Field 5G.
W85-05943

STATE INITIATIVES IN NONPOINT-SOURCE POLLUTION CONTROL,
Association of State and Interstate Water Pollution Control Administrators, Washington, DC.
For primary bibliographic entry see Field 5G.
W85-05946

NONPOINT POLLUTION CONTROL: THE WISCONSIN EXPERIENCE,
Wisconsin Dept. of Natural Resources, Madison. Nonpoint Source and Land Management Section.
For primary bibliographic entry see Field 5G.
W85-05947

CONSERVATION DISTRICT ROLE IN NONPOINT POLLUTION CONTROL,
National Association of Conservation Districts, Washington, DC.
For primary bibliographic entry see Field 5G.
W85-05948

SETTING AGRICULTURAL POLLUTION CONTROL PRIORITIES,
Idaho Soil Conservation Commission, Boise.
For primary bibliographic entry see Field 5G.
W85-05949

SUCCESSFUL WATER QUALITY PLANNING: AN AREAWIDE PERSPECTIVE,
Southern California Association of Governments, Los Angeles. Water Quality and Waste Management Program.
For primary bibliographic entry see Field 5G.
W85-05952

LOGGING AND WATER QUALITY; STATE REGULATION IN NEW ENGLAND,
Maine State Planning Office, Augusta.
For primary bibliographic entry see Field 5G.
W85-05959

COST-EFFECTIVE TARGETING OF AGRICULTURAL NONPOINT-SOURCE POLLUTION CONTROLS,
Tennessee Valley Authority, Knoxville. Environmental Quality Staff.
For primary bibliographic entry see Field 5G.
W85-05960

AGRICULTURAL NONPOINT POLLUTION CONTROL: VOLUNTARY OR MANDATORY,
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
For primary bibliographic entry see Field 5G.
W85-05961

SOIL LOSS REDUCTION IN FINLEY CREEK, INDIANA: AN ECONOMIC ANALYSIS OF ALTERNATIVE POLICIES,
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W85-05963

GROUNDWATER PROTECTION: A CONTRAST IN STATE STYLE,
Kellogg Corp., Littleton, CO.
For primary bibliographic entry see Field 5G.
W85-05979

DEMANDS PLACED ON PROCESSING PLANTS BY DEVELOPMENTS IN LEGISLATION FOR THE PROTECTION OF WATER (ANFORDERUNGEN AN VERFAHRENSTECHNISCHE ANLAGEN DURCH DIE WEITERENTWICKLUNG DER GEWASSERSCHUTZ-VORSCHRIFTEN),
Hoechst A.G., Frankfurt-am-Main (Germany, F.R.).
H.-O. Braubach, E. Sommer, and K. Zellman.
Chemie Ingenieur Technik, Vol. 57, No. 2, p 113-118, February, 1985. 4 Fig, 1 Tab, 11 Ref.

Descriptors: *Water pollution control, *Legislation, *Germany (Federal Republic), Oil pollution, Industrial plants, Hazardous materials, Materials storage, Regulations.

Initial legislation for protection of water against pollution was limited to general regulations ensuring safe storage of mineral oil products, especially fuel oil. In the course of time, the requirements became more and more detailed and extended to cover all substances representing a potential source of danger to water (not only liquids) and plants serving purposes other than the storage of water-endangering substances. The developments from the Federal Republic of Germany 1st Water Ecology Act dating from 1960 to the state regulations concerning plant for the storage, filling, and transferring of water-endangering substances are described. (Author's abstract)
W85-05982

MINIMUM FLOW PROTECTION IN RIPARIAN STATES,
Patterson (J.W.) and Associates, Inc., Denver, CO.
W. D. Dixon, and W. E. Cox.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 149-156, April, 1985. 30 Ref.

Descriptors: *Minimum flow, *Legal aspects, Instream use, Water management, Riparian lands, Riparian law, Legislation, State jurisdiction, Water use.

Maintenance of minimum flows necessary for protection of instream water uses has been recognized as a significant water management issue in some of the eastern states. The riparian doctrine, a primary component of the water law of several eastern states, offers some protection to instream uses since its offers protection to riparian land values and requires a sharing of water among landowners along the length of each stream. In addition, legal provisions for recognition of instream uses in federal water management programs apply, and many of the eastern states have adopted applicable legislative measures such as direct controls over water use, programs for preservation of scenic rivers, and minimum release requirements for impoundments. However, such measures do not apply uniformly among the riparian states, and existing legal mechanisms may be inadequate in some cases. Therefore, additional institutional development will likely be necessary to assure continuance of a socially desirable balance between instream and offstream water uses as water demand increases over time. (Author's abstract)
W85-06028

SATISFYING INSTREAM FLOW NEEDS UNDER WESTERN WATER RIGHTS,
Utah Water Research Lab., Logan.
J. M. Bagley, D. T. Larson, and L. Kapaloski.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 171-191, April, 1985. 18 Ref.

Descriptors: *Instream flow, *Water rights, Appropriation, Litigation, State jurisdiction, Legal aspects, Environmental effects.

The appropriation system of water rights has been criticized for failure to provide adequate protection of instream flow values. The appropriation system is measured against 13 fundamental principles of good state water law. Within the context of this comparison, the implications with respect to accommodating instream flow uses are examined. It is concluded that the appropriation system can equitably incorporate instream flow uses, but is constrained by lack of 'litigation proof' methodologies and technologies to project impacts and tradeoffs. The integration of instream flow rights is also retarded by lack of proper recognition of certain hydrologic imperatives that must be observed in order to correctly define the instream flow right. Instream flow rights must not upset the integrity of other rights within the common system. (Author's abstract)
W85-06030

EXPORTING COLORADO WATER IN COAL SLURRY PIPELINES,
Wisconsin Univ.-Madison. Law School.
D. T. Massey.
Journal of Water Resources Planning and Management, Vol. 111, No. 2, p 207, 221, April, 1985. 59 Ref, 1 Append.

Descriptors: *Water exporting, *Coal slurry pipelines, *Colorado, *Water law, Diversion, Legal aspects, Water supply, Commerce clause, State jurisdiction, Interstate commerce.

The San Marco Pipeline Company has proposed a 1,000-mile (1,610-km) pipeline system to move coal slurry from southeastern Colorado to several electrical generating plants in the Texas Gulf Coast area. This area of Colorado is experiencing severe water shortage problems due to the large amount of water used for irrigation. Colorado statutes restrict the diversion of both surface and ground water for out-of-state use unless such water is credited to interstate compacts. Water has been found by the courts to be a commodity or article of commerce, therefore subject to federal constitutional scrutiny under the commerce clause. The constitutionality of Colorado's statutes depends upon the nature of the restrictions imposed, the severity of the burden created, and the local purposes served by the statutes. Statutes will be upheld only where they incidentally burden or discriminate against interstate commerce. States may impose severe restrictions on diverting water for out-of-state uses provided the same type of restrictions are imposed on in-state use. (Author's abstract)
W85-06032

6F. Nonstructural Alternatives

CALCULATING EFFECTIVENESS OF WATER CONSERVATION MEASURES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. M. Walski, W. G. Richards, D. J. McCall, A. K. Deb, and J. M. Morgan.
Journal of Environmental Engineering, Vol. 111, No. 2, p 209-221, April, 1985. 1 Fig, 4 Tab, 25 Ref, 1 Append.

Descriptors: *Water conservation, *Effectiveness, *Water demand, Utilities, Water treatment facilities, Pumping capacity, Algorithms, Computers.

As it becomes more expensive to develop new water sources and expand treatment and pumping capacities, water utilities are considering water conservation to reduce the need for capacity expansion for municipal and industrial water uses. Engineers and planners working with utilities need to be able to predict the reduction in water requirements (i.e., effectiveness of water conservation) that will result from implementation of water conservation measures. A procedure that was developed to help water conservation effectiveness for typical conditions is presented. To adequately detemine the efectiveness of water conservation measures, the engineer or planner must determine the effectiveness of each measure on each use sector and dimensions while accounting for coverage of each measure and interaction between measures. The algorithm described in this paper provides the framework; tables provide typical values; and the MAPS computer program greatly simplifies calculations. (Moore-IVI)
W85-06021

6G. Ecologic Impact Of Water Development

RESPONSES OF FISH POPULATIONS TO MITIGATION STRUCTURES IN TWO SMALL CHANNELIZED STREAMS IN OHIO,
Ohio Cooperative Fishery Research Unit, Columbus.
R. F. Carline, and S. P. Klosiewski.
North American Journal of Fisheries Management, Vol. 5, No. 1, p 1-11, 1985. 3 Fig, 3 Tab, 20 Ref.

Descriptors: *Ohio, *Fish populations, *Channelization, *Mitigation structures, *River Styx, *Chippewa Creek, *Ohio, Riffles, Deflectors, Deflection, Fish reproduction.

Responses of fish populations to mitigation structures (rock deflectors and artificial riffles) were compared in two small channelized streams in Ohio to determine potential recreational benefits of such structures. In Chippewa Creek, fish populations were compared 1 and 3 years after construction in sections with and without rock deflectors. In River Styx, previously altered around 1950, fish fauna were compared 1 year before and 1 year after channelization in sections with and without mitigation devices. Sections with rock deflectors in Chippewa Creek supported significantly more species and higher numbers and biomass of fish than did sections without structures. In River Styx, fish populations before construction and 1 year afterwards were similar; low flows prior to channelization and above-average flows afterwards probably had more influence on fish populations than the habitat changes. Stations with deflectors or artificial riffles tended to support greater densities of fish than stations without mitigation structures, although differences were not statistically significant. Deflectors created apparently favorable habitat for centrarchid species, yet their small sizes (primary juveniles) and low densities in both streams provided limited sport fishing opportunities. The primary limiting factor for the centrarchids may have been reproductive failure due to erratic flows rather than inadequate habitat. (Author's abstract)
W85-05877

GENERALIZED MODEL FOR PREDICTING SPAWNING SUCCESS OF FISH IN RESERVOIRS WITH FLUCTUATING WATER LEVELS,
Virginia Cooperative Fishery Unit, Blacksburg.
D. H. Bennett, O. E. Maughan, and D. B. Jester, Jr.
North American Journal of Fisheries Management, Vol. 5, No. 1, p 12-20, 1985. 2 Fig, 2 Tab, 27 Ref.

Descriptors: *Fisheries, *Computer models, *Spawning, *Reservoirs, *Water levels, *Leesville Lake, *Roanoke, *Virginia, Model studies, Water temperature, Bluegills, Ecological effects.

A computer model (SUCCESS) was developed to predict spawning success of centrarchid fishes in a pumped storage reservoir. The model was quantified by conducting field and laboratory studies with bluegills (Lepomis macrochirus) from Leesville Lake, the lower impoundment of the Smith Mountain Pumped Project near Roanoke, Virginia. Eight modifiable subprograms were used to increase the generality and utility of the model. Data

necessary for use in the model are hourly water levels, water temperature regimens, and a distribution describing the depth of spawning activity in the reservoir. A sensitivity analysis of the model suggested that data in hatchability and rates of hatching and development from the fry to free-swimming stage had the greatest effect on the estimates of spawning success. SUCCESS should allow a reservoir fishery manager to predict the impact of water level fluctuations on spawning success of sport fishes or predict spawning success of undesirable species under various water level fluctuation regimens. (Author's abstract)
W85-05878

MORTALITY OF ADULT AMERICAN SHAD PASSING THROUGH A 17-MEGAWATT KAPLAN TURBINE AT A LOW-HEAD HYDROELECTRIC DAM,
Massachusetts Cooperative Fishery Research Unit, Amherst.
C. E. Bell, and B. Kynard.
North American Journal of Fisheries Management, Vol. 5, No. 1, p 33-38, 1985. 3 Fig, 1 Tab, 21 Ref.

Descriptors: *Shad, *Fish mortality, *Turbines, *Hydroelectric dams, *Holyoke Dam, *Connecticut River, *Massachusetts, Radio telemetry, Fish behavior.

The mortality of pre-spawning American shad (Alosa sapidissima) was investigated in May 1982 over a 5-hour period after passage through the 17-megawatt Kaplan turbine at Holyoke Dam, Connecticut River, Massachusetts. Radio telemetry was used to determine the survival of 36 test fish during 7 experiments by comparing their movement patterns with those of 21 sacrificed fish that were also passed through the turbine. Sixty-nine control fish fitted with dummy tags were released and held in an instream net for direct observation of mortality due to handling, tagging, and introduction procedures. The mean turbine mortality (N sub T) was 21.5% (95% confidence limits of 3.3-36.2%). Similar preliminary experiments with post-spawned American shad indicated that mortalities during their normal outmigration should be higher than the mortality estimate for prespawned fish. (Author's abstract)
W85-05879

AQUATIC INSECT ABUNDANCE IN A REGULATED STREAM UNDER FLUCTUATING AND STABLE DIEL FLOW PATTERNS,
Washington Univ., Seattle. Fisheries Research Inst.
For primary bibliographic entry see Field 2H.
W85-05880

IRON MIGRATION IN SANDY PODZOLIC SOILS UNDER INCREASING HYDROMORPHISM PRODUCED BY A RESERVOIR,
Moskovskaya Sel'skokhozyaistvennaya Akademiya (USSR).
A. D. Fokin, V. A. Varlamov, and T. S. Man'kova.
Soviet Soil Science, No. 6, p 72-80, May-June, 1984. 3 Fig, 2 Tab, 14 Ref. Translated from Pochvovedeniye, No. 6, p 31-39, 1984.

Descriptors: *Soil water, *Path of pollutants, *Iron, *Environmental effects, *Podzolic soil, *Reservoirs, Dam effects, Wetting, Groundwater movement, Aluminum, Humus, Solute transport, Water table.

Under the effect of a change in the wetting regime in the reservoir zone, a considerable change was noted in the direction of conversion and migration of substances. This change lead to the destruction of Al-Fe humus horizons and to the removal and redeposition of the products of this destruction in the area. The increase in the wetting of the area surrounding a reservoir has a significant effect on iron migration in sandy Podzolic and Bog Podzolic soils when the groundwater table stands higher than the depth of soil horizons a considerable part of the time. The change in the regime of iron migration in soils is apparently intensified by irregular groundwater level variations, accompanied by lateral water inflow or outflow, and also by a high water table in summer. A change in groundwater regime significantly changes the migration regime of precipitation water and, correspondingly that of dissolved substances primarily in AO horizons. The change consists mainly in a sharp reduction of vertical soil wetting and intensification of lateral flows, which predominate even in summer. Illuvial horizons are destroyed and the products of destruction are removed under conditions of prolonged excessive wetting of soil horizons by groundwater and also of irregular groundwater inflow and outflow. Experimental investigations and calculations show that it requires 20-45 years for a horizon to change by 90%. The destruction of illuvial horizons is accompanied by the bleaching of the mineral layer of Podzolic soils to a considerable depth (of about 1 m or more), by considerable removal of iron from the area, and by the formation of different forms of contemporary iron accumulations along the paths of migration (at the soil surface, in the plant cover, in thalwegs, in the eluvial part of the profile, etc). The regime of migration of atmospheric water modified by a rise in the groundwater table promotes the irreversible removal of various substances from AO horizons because of the increased duration and intensity of surface runoff. All the observations suggest that changes in the soil under the influence of increasing hydromorphism are generally directed toward a considerable decrease in the water-holding capacity and water-regulating function of soils as a result of the destruction of illuvial horizons and also toward a considerable loss of all the elements from litter. These changes may cause a further deep transformation of all the elements of the area's landscape. (Baker-IVI)
W85-05909

SALINATION OF ORGANIC SOILS IN THE SACRAMENTO-SAN JOAQUIN DELTA OF CALIFORNIA,
California Univ., Stockton. Cooperative Extension Service.
For primary bibliographic entry see Field 3F.
W85-05927

EFFECT OF IRRIGATION PRACTICES IN THE BREE RIVER VALLEY ON THE SALT CONTENT OF A SMALL RIVER,
Rhodes Univ., Grahamstown (South Africa). Hydrological Research Unit.
For primary bibliographic entry see Field 5B.
W85-05928

REGIONAL WATER QUALITY IMPACTS OF INTENSIVE ROW-CROP AGRICULTURE: A LAKE ERIE BASIN CASE STUDY,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5B.
W85-05962

CHANNEL CHANGES AND INVERTEBRATE FAUNAS BELOW NANT-Y-MOCH DAM, RIVER RHEIDOL, WALES, UK,
Loughborough Univ. of Technology (England). Dept. of Geography.
G. E. Petts, and M. Greenwood.
Hydrobiologia, Vol. 122, No. 1, p 65-80, March, 1985. 7 Fig, 4 Tab, 47 Ref, 2 Append.

Descriptors: *Dam effects, *Ecological effects, *Invertebrates, *Rheidol, *Wales, Channel morphology, Sedimentation, Hydraulic sorting, Aggradation, Fauna, Environmental effects.

Since 1961, runoff from 93% of the catchment of the Rheidol above the study area has been controlled by the Nant-y-Moch reservoir, which releases a compensation flow of only 0.16 cu m/s. The flow varies rarely, rising to a maximum of 40 cu m/s on only three occasions. The marked reduction of flow variability along the mainstream initiated a sequence of morphological changes, manifested by channel sedimentation at tributary confluences. Sedimentation is particularly apparent at the confluence of the Peithnant tributary. Channel sedimentation below the tributary confluence, resulting from reduced flow competence and capacity within the regulated mainstream, produced morphological changes associated with substrate particle-size alteration. Four physical compartments are identified, each representing a different stage of readjustment to the hydrological conditions imposed by the dam. The four channel compartments within the regulated river reflect four stages of channel response: the stabilized, relic form downstream forms the limit of current sedimentation; a form in the early stages of channel change associated with bed aggradation of fine gravels and sands; a late stage, braided form undergoing both aggradation and lateral accretion by coarse gravels; and an adjusted quasi-equilibrium section nearest the sediment source. Each stage has a characteristic fauna. Hydraulic sorting during the early stages of channel form adjustment created a new diversity of micro-habitats. As the channel width is reduced and slope increased (as the channel attains a new quasi-equilibrium form, the species diversity declines and finally approximates that of the natural river above the dam. (Moore-IVI)
W85-06007

EVALUATION OF ARTIFICIAL WETLANDS IN NORTH DAKOTA: RECOMMENDATIONS FOR FUTURE DESIGN AND CONSTRUCTION,
J. A. Rossiter, and R. D. Crawford.
Transportation Research Record, Vol. 948, p 21-25, 1984. 3 Fig, 29 Ref.

Descriptors: *Artificial wetlands, *Design criteria, *Highways, *North Dakota, Construction, Wetlands, Waterfowl, Habitats, Aquatic plants.

Eighteen artificial wetlands were evaluated in North Dakota in 1979 and 1980. Several recommendations are presented for artificial wetland design and construction based on both the results of the 2 year study and the habitat requirements of breeding waterfowl. It is recommended that a series of wetlands of varying sizes be built rather than one large wetland; that multisided, variable-depth wetlands be excavated instead of rectangular, uniformly deep borrow pits; that bank gradients not exceed a 10:1 to 20:1 slope; that nesting islands be constructed in the center of the wetland when possible; that adjacent upland areas be seeded with dense cover to support nesting and reduce erosion and runoff; that, if necessary, wetlands be sealed with a clay layer to retain water; and that topsoil be set aside and respread to provide an adequate substrate for the growth of aquatic plants. What is currently needed is a long term study of a natural wetland before highway construction and, later, an evaluation of the artificial wetland that replaced it. Only then can it be determined how well habitat can be reconstructed. (Baker-IVI)
W85-06066

IMPACT OF BRIDGING ON FLOODPLAINS,
Y. A. Yousef, M. P. Wanielista, H. H. Harper, and E. T. Skene.
Transportation Research Record, Vol. 948, p 26-30, 1984. 3 Fig, 4 Tab, 9 Ref.

Descriptors: *Water pollution sources, *Bridges, *Environmental effects, *Floodplains, Metals, Algal growth, Eutrophication, Organic compounds, Path of pollutants, Lead, Zinc, Copper, Iron, Nickel, Chromium, Cadmium,.

Three bridge sites in central Florida were selected to study the feasibility of treating highway runoff by using floodplains beneath these bridges and the impact of bridging on biological diversity and productivity. Soil and plant samples were collected from bridge areas affected by highway runoff as well as control areas upstream and downstream of the bridge areas. These samples were analyzed for extractable heavy metals to study the capacity of floodplain areas to retain these metals. The concentrations of several heavy metals extracted from soil samples at the bridge areas were significantly higher than concentrations of similar metals extracted from the control areas upstream and downstream of each bridge site. Most of the extractable heavy metals were found in the highest amounts in

soils areas where the average daily traffic count and percentage of organic and clay content were highest. The existing levels of lead in soils from the study sites were far below the lead uptake capacity determined by slurry tests from lab experiments. Heavy metals retained by floodplain soils can be released back to solution by lowering pH values, reducing environments, and soluble chelating organic complexes. A fraction of heavy metals retained by floodplain soils is available for biological uptake by plants and other forms of life. Plant communities at bridge areas and control areas were generally similar. Bridge areas appeared to be dominated by fewer species than control areas. There were more individuals of any common plant species in the bridge areas than in other control areas. The algal bioassay experiments have shown that bridge runoff has the potential to increase algal production in nearby streams considerably. The use of floodplain systems in treating bridge runoff appeared to be feasible, and there were no noticeable detrimental effects in the study areas. (Baker-IVI)
W85-06067

ENVIRONMENTAL IMPLICATIONS OF THE FUNDY BAY TIDAL POWER DEVELOPMENT,
Acadia Univ., Wolfville (Nova Scotia). Dept. of Biology.
G. R. Daborn.
International Water Power and Dam Construction, Vol. 37, No. 4, p 15-19, April 1985. 3 Fig, 14 Ref.

Descriptors: *Tidal powerplants, *Environmental effects, *Bay of Fundy, *Nova Scotia, *New Brunswick, Flooding, Estuarine environment, Harbors, Fisheries, Tidewaters, Barrages, Water resources development.

The massive tides in the Bay of Fundy represent approximately 1% of the global tidal energy. Many proposals have been advanced for harnessing this power over the past 7 decades. The Cumberland basin proposal calls for a 1.5 km long barrage built of concrete caissons, containing 37 turbines about 7 m in diameter, each having a rated output of 31 MW. The installed capacity would be 1147 Mw and the yield 3183 GWh. Construction of the proposed tidal power barrage would introduce major changes to this dynamic environment. Problems thus far identified include flooding of coastal property, increased flushing of estuaries, changed current and sedimentation patterns, interference with the use of harbors, increased shoreline erosion and increased impact of storm surges. On the positive side, increasing the tidal range should improve dispersion of effluents from estuaries, improve accessibility of some harbors at high water, increase intertidal areas and their shellfish resources, and increase tidal mixing over shallow banks where the major fisheries occur. (Baker-IVI)
W85-06127

IMPACT OF HYDRAULIC WORKS ON WATER QUALITY,
Electricite de France, Chatou. Direction des Etudes et Recherches.
R. Gras, and J. P. Albignat.
International Water Power and Dam Construction, Vol. 37, No. 4, p 45-48, April, 1985. 5 Fig.

Descriptors: *Hydraulic structures, *Water quality, *Environmental effects, Reservoirs, Weirs, Dam effects, Tidal powerplants, Ecosystems, Plankton, Fish, Pumped storage, Hydroelectric plants.

Various types of hydraulic projects are reviewed to examine their impact on the environment, and in particular on water quality and aquatic life. Particular attention is paid to the canalization of streams or rivers, construction of dams for power generation and navigation; and reservoirs and pumped storage stations. Some information is also given on estuarine projects, such as tidal powerplants. The main water quality parameters are considered with special attention to thermal behavior. Physico-chemical parameters are considered as well as those concerning aquatic flora and fauna (plankton and fish resources). Specific examples are examined for most of these type of projects. An analysis is offered of the way in which the operating mode can affect the quality of the water and the downstream section of the stream is analyzed as for a reservoir. (Baker-IVI)
W85-06132

ENVIRONMENTAL IMPACT OF DAMS,
World Commission on Environment and Development, Geneva (Switzerland).
E. Monosowski.
International Water Power and Dam Construction, Vol. 37, No. 4, p 48-50 and 61, April, 1985. 1 Fig, 3 Ref.

Descriptors: *Environmental impact statement, *Dam effects, *Environmental effects, Social aspects, Ecological effects, Water resources development.

In addition to their benefits, water projects in many countries have been the source of significant environmental change, unexpected diseases, the impoverishment of aquatic fauna and decrease of water quality. Local people have been seriously affected by resettlement. Cases studied illustrate some common problems faced in the practice of Environmental Impact Assessment (EIA) on dams. Environment is generally identified with natural physical systems. The studies often adopt limited time and space boundaries for impact evaluation. All the studies analyze the effects on water quality, on biotope, and the resettlement of populations. A strong emphasis is also given to the direct impacts of the project over the physical elements of environment. Less importance is accorded to the indirect impacts of the project at the regional level and social organization, or its interaction with other large-scale development projects in the region. Very different levels of priority are given to the social impacts among the case studies. (Moore-IVI)
W85-06133

7. RESOURCES DATA

7B. Data Acquisition

COMPARISON OF METHODS USED TO ESTIMATE EVAPOTRANSPIRATION FOR LEACHING CONTROL,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
D. Devitt, W. A. Jury, P. Sternberg, and L. H. Stolzy.
Irrigation Science, Vol. 4, No. 1, p 59-69, April, 1983. 5 Fig, 3 Tab, 11 Ref.

Descriptors: *Evapotranspiration, *Leaching, *Crop yield, Irrigation management, Water use, Water application, Wastewater irrigation, Irrigation, Penman Equation.

Procedures were analyzed for minimum leaching fraction irrigation management based upon weekly averaged evapotranspiration feedback. Of all the methods tested for maintaining uniform leaching fraction, the Doorenbos and Pruitt weekly averaged Penman equation proved to be the most accurate. This method had a +/- 15% error which when coupled with the natural spatial variability of the water application regime would give significant variation in leaching fraction across the field even when high technology methods for water application such as solid set sprinklers are used. Such natural limitations to maintaining constant leaching factions will become progressively more severe when smaller leaching fractions are required. There seems to be a practical lower limit to the lowest leaching reaction that can be maintained on a field while also maintaining high crop yields. If the water is being managed primarily for disposal, then little concern need be raised over the part of the field which receives a leaching fraction which would reduce crop yields. (Baker-IVI)
W85-05926

CHLOROPHYLL FLUORESCENCE INDUCTION: A SENSITIVE INDICATOR OF WATER STRESS IN MAIZE PLANTS,
Universite Libre de Bruxelles (Belgium).Lab. de Physiologie Vegetale.
For primary bibliographic entry see Field 2I.
W85-05931

ON-SITE TESTS OF A SEGMENTAL CONSTRICTION AS A FLOWMETER IN LARGE DIAMETER PIPES,
For primary bibliographic entry see Field 8A.
W85-05985

CHLOROPHYLL DIFFERENCES IN MONO LAKE (CALIFORNIA) OBSERVABLE ON LANDSAT IMAGERY,
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 2H.
W85-06004

MULTIPURPOSE HEAD DETECTION AND MONITORING UNIT,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
A. J. Clemmens, and A. R. Dedrick.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 6, p 1825-1828, November-December, 1984. 3 Fig, 2 Tab, 3 Ref.

Descriptors: *Head detection, *Water level, *Monitoring, Data acquisition, Data processing, Water management, Channel flow.

A water level (head) detection unit was developed which is versatile in its application. The system used an inexpensive pressure transducer and double-bubbler scheme for sensing water head. The double-bubbler scheme provides a method for continual calibration of the pressure transducer (offset and gain compensated). Head detection accuracy was within + or - 1 mm over a wide temperature range. This scheme is monitored and controlled by a hand-held programmable electronic calculator. The calculator and peripheral devices can be used to compute a variety of parameters of interest. This unit has been used along with a measuring flume or weir to record and accumulate flow. It had also been used to monitor infiltration for a flowing furrow infiltrometer. The unit can also be adapted to record water levels from several locations. Since the unit is programmed by simple calculator functions, it is rather simple to convert to new applications. (Author's abstract)
W85-06094

RIVER GAUGING BY ULTRASONICS IN OPEN CHANNELS: INSTRUMENTS AND EXPERIENCE ABROAD (ABFLUSSERMITTLUNG IN OFFENEN GERINNEN MITTELS ULTRASCHALLMESSUNG: IM AUSLAND EINGESETZTE GERATE UND GEWONNENE ERFAHRUNGEN),
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wasserbau und Wasserwirtschaft.
For primary bibliographic entry see Field 2E.
W85-06157

7C. Evaluation, Processing and Publication

RESOLVING THIESSEN POLYGONS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2A.
W85-06054

8. ENGINEERING WORKS

8A. Structures

ON-SITE TESTS OF A SEGMENTAL CONSTRICTION AS A FLOWMETER IN LARGE DIAMETER PIPES,
B. M. Levin, V. M. Nekrasov, B. A. Chavtaraev,

A. N. Lopatin, and I. K. Dudenko.
Hydrotechnical Construction, Vol. 18, No. 6, p 248-253, June, 1984. 4 Fig, 8 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 12-16, June, 1984.

Descriptors: *Flowmeters, *Segmental constriction, *Pipelines, Flow measurement, Pressurized flow.

On-site tests of a flowmeter with a segmental constriction were conducted on a 3.6 m diameter pressure pipeline at flow rates of 36 to 40 cu m per s. The difference between the results of measuring the flow rate by the segmental meter and the velocity-area method did not exceed 1 to 2%. On the basis of these tests, segmental constrictions are recommended for wide use as flowmeters of pressurized (included suspension transporting) flows in pipes of any diameter. (Keenan-IVI)
W85-05985

ECOLOGICAL ASPECTS OF THE DESIGN AND OPERATION OF CONDUITS OF HYDROELECTRIC SCHEMES,
For primary bibliographic entry see Field 5G.
W85-05986

FINITE ELEMENT ANALYSES OF LOCK AND DAM 26 COFFERDAM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
G. W. Clough, and T. Kuppusamy.
Journal of Geotechnical Engineering, Vol. 111, No. 4, p 521-541, April, 1985. 14 Fig, 3 Tab, 15 Ref, 1 Append.

Descriptors: *Cofferdams, *Design criteria, *Finite element analysis, Model studies, Sheet-piles, Soil mechanics, Construction, Simulation, Seepage, Cellular cofferdams.

Replacement of the old Lock and Dam 26 on the Mississippi River involves construction of one of the largest systems of cellular cofferdams ever built. Preliminary analyses using conventional theories led to sometimes contradictory recommendations about the cofferdam design. To help resolve outstanding issues, instrumentation was placed on the first-stage cofferdam, and finite element procedures were developed for analysis of the cofferdam. Three different two-dimensional finite element procedures were generated, including axisymmetric, vertical slice, and generalized plane-strain models. The alternative approaches allowed prediction of cofferdam response for the most important design conditions and at the critical locations. In all models, allowances were made for nonlinear soil response, slippage on the sheet-pile-soil interfaces, staged construction simulation and seepage effects where appropriate. Further, a means was provided to accommodate the effect of sheet-pile interlock yielding, which led to an orthotropic response of the cellular cofferdam. Predicted behavior from the finite element models was found to be consistent with observed trends. The models appear to have considerable potential for use in future designs. (Author's abstract)
W85-06025

UNDERGROUND DESIGN AT ANDEKALEKA HYDROELECTRIC DEVELOPMENT,
Montreal Engineering Co. Ltd. (Quebec).
R. W. Humphries, and L. T. Jory.
Canadian Geotechnical Journal, Vol. 22, No. 1, p 25-31, February, 1985. 11 Fig, 7 Ref.

Descriptors: *Underground structures, *Design criteria, *Andekaleka Hydroelectric Development, *Malagasy Republic, *Madagascar, Hydroelectric plants, Tunnels, Penstocks, Underground powerplants, Excavation, Laterites, Geological formations.

Andekaleka Hydroelectric Development is located on the Vohitra River, Madagascar, Republic of Malagasy. The hydroelectric development comprises an 8 m high intake dam, a 4 km long unlined power tunnel, a surge shaft, a concrete-lined penstock, four steel-lined branch penstocks, an underground powerhouse, and a 0.5 km long tailrace tunnel. The scheme develops a 235 m fall in the Vohitra River. Two 29 MW Francis turbines have been installed, with space left in the underground powerhouse for two more identical units. Standard drill-and-blast, full-face techniques, and haulage by rubber-tired trucks were used for all underground excavations. The predominant rock type is good quality granitic gneiss, which required minimal underground support and lining. Of particular geotechnical interest are the successful construction of the powerhouse arch supported by rockbolts and reinforced shotcrete; the crane beams supported on rock shoulders; the steel lining of the penstocks restricted the branch penstocks; and the aboveground pipe crossing into laterite slopes, of the power tunnel over the Sahantsiva River. Laterite slopes in key areas have remained stable since watering up. (Moore-IVI)
W85-06043

HYDRAULIC DESIGN OF STORMWATER PUMPING STATIONS: THE EFFECT OF STORAGE,
R. H. Baumgardner.
Transportation Research Record, Vol 948, p 63-70, 1984. 15 Fig, 4 Tab, 2 Ref.

Descriptors: *Hydraulic design, *Design criteria, *Storage, *Storm water, *Pumping stations, Basins, Sediment, Storm drains.

Design guidance is provided for sizing storage facilities used to reduce peak rates of flow at stormwater pumping stations. Estimation of required storage and pumping rates are worked out in an example. Mass curve routing procedures may be used to analyze the design problem once the interrelationships among the following three factors are known: (1) the inflow hydrograph for the contributing watershed, (2) the volumetric storage capacity of the storage facility, and (3) the stage-discharge curve of the pumps. Appropriate formulas and methods must be used for finding the stage-storage relationships in natural earth basins, trapezoidal basins, storm drains, or storage boxes. In application of the mass curve routing procedure, the inflow hydrograph is a fixed design component, and the storage capacity and pumping discharge rates are variables. A design pumping discharge rate may be assigned based on environmental or downstream capacity considerations, with the required storage being determined by various trials of the routing procedure. An inflow mass curve and pump discharge curve are used to determine the amount of required storage capacity. In the final design, the mass curve routing procedure can be fine-tuned after the pumps have been selected. Handling of sediment remains a difficult problem in pumping station design. The storage pipe and wet well should be designed to handle sediment; the pumping system should be designed to carry sediment-laden stormwater in case sediment removal does not occur in the wet well. (Rochester-IVI)
W85-06072

CASE HISTORIES OF SCOUR PROBLEMS AT BRIDGES,
S. R. Davis.
Transportation Research Record, Vol. 950, No. 2, p 149-155, 1984. 8 Fig, 6 Ref.

Descriptors: *Scour, *Bridges, Design criteria, Mathematical models, Streambeds, Bridge design, Bridge failure, River beds.

Designing bridge foundations to resist scour is still a technical area that requires engineering judgment by experienced bridge and hydraulic engineers, and evidence indicates that additional attention to designing for scour is needed. Formulas and mathematical models are still based primarily on theoretical approaches and laboratory tests because of the lack of verifiable field data. Ten case histories of scour problems at bridges were analyzed as a review of the various factors contributing to the problems, corrective actions taken, and the influence of the events on current design practices. Designing bridge foundations remains a technical area that requires use of sound engineering judgement to evaluate field conditions and to apply state of the art knowledge of river mechanics to arrive at a cost effective foundation design. Both of these aspects should be applied on a case by case basis to a degree commensurate with the potential risks and consequences of the loss of the bridge to scour. Analyzing case histories should be used as a means of understanding the conditions and events that contribute to bridge scour and ways to avoid or alleviate scour problems. (Collier-IVI)
W85-06107

ASSESSMENT OF CHANNEL STABILITY AT BRIDGES SITES,
J. C. Brice.
Transportation Research Report, Vol. 950, No. 2, p 163-171, 1984. 11 Fig, 15 Ref.

Descriptors: *Channel morphology, *Bridges, *Aerial photography, *Erosion, Streambeds, River beds, Bank erosion.

Assessment of channel stability from field study and the comparison of time-sequential aerial photographs provides information that is needed in site selection, bridge design, and countermeasure placement. Channel instability is indicated by bank erosion, progressive degradation (or aggradation) of the streambed, or natural scour and fill of the streambed. Bank erosion rates are related to stream type and are proportional to stream size. Predictions of future rates are based on past rates, as measured on time-sequential photographs or maps, and on the typical behavior of meander loops. Significant degradation of the streambed can usually be detected from indirect field evidence. The sites of greatest potential scour along a channel can be identified from channel configuration. Shift of the thalweg, which is a factor in the alignment of piers, is related to stream type and can be assessed from aerial photographs. (Author's abstract)
W85-06109

USE OF SPURS AND GUIDEBANKS FOR HIGHWAY CROSSINGS,
E. V. Richardson, and D. B. Simons.
Transportation Research Record, Vol. 950, No. 2, p 184-193, 1984. 13 Fig, 1 Tab, 48 Ref.

Descriptors: *Road consruction, *Highway crossings, *Bridge construction, Stream morphology, Spur dikes, Dikes, Jetties, Guidebanks, Erosion control, Scour.

Bridge engineers often need to protect bridge abutments from scour; maintain, stabilize, and improve the alignment of a stream approaching a bridge crossing; protect the bank of a stream along a highway; maintain a stream in a given location; maintain or decrease the width of a stream; protect highway approaches to a bridge crossing across flood plains; and improve the hydraulic characteristics of the bridge opening. Spurs and guidebanks are structures river engineers use to fill this need. Other names for spurs are dikes, jetties, spur dikes, retards, and dyke fields. Spurs and guidebanks are described and design recommendations based on a literature review are given. (Author's abstract)
W85-06111

DESIGN GUIDELINES FOR SPUR-TYPE FLOW-CONTROL STRUCTURES,
S. A. Brown.
Transportation Research Record, Vol. 950, No. 2, p 193-201, 1984. 9 Fig, 5 Ref.

Descriptors: *Design criteria, *Spurs, *Channel flow, *Bank protection, Bank stabilization, Stream stabilization, Scour.

Spurs are defined as permeable or impermeable linear structures that project into a channel to alter flow direction, induce deposition, or reduce flow velocities along a channel bank. Spurs can be classified by function as retardance structures (permeable), retardance-diverter structures (permeable), and diverter structures (impermeable). The applicability and design of spur-type flow-control and stream-bank stabilization structures was studied to

establish design guidelines for the use of spurs. The study was conducted jointly by the Sutron Corporation and the Pennsylvania State University for FHWA. Recommendations for the general application of spur-type flow-control structures are given in relation to the function of the spur, the erosion mechanisms that are countered by spurs, the environmental conditions best suited for the use of spurs, and potential negative impacts produced by spurs. Possible design shapes for the head or riverward tip of the spur include straight, T-head, L-head, hocky, and inverted hocky; the recommended form is the simple straight spur-head. The spur tip should be as smooth and rounded as possible; smooth, well-rounded spur tips help minimize local scour and flow velocities at the spur tip. (Collier-IVI)
W85-06112

RIPRAP STABILITY ANALYSIS,
For primary bibliographic entry see Field 2J.
W85-06114

ANALYSIS OF COMMONLY USED RIPRAP DESIGN GUIDES BASED ON EXTENDED SHIELDS DIAGRAM,
For primary bibliographic entry see Field 2J.
W85-06115

ASSESSING VULNERABILITY OF BRIDGES TO FLOODS,
E. M. Laursen.
Transportation Research Record, Vol. 950, No. 2, p 222-229, 1984. 9 Fig, 29 Ref. FHWA Research Project HRP-1-19(184).

Descriptors: *Flood damage, *Bridges, *Design criteria, Evaluation, Construction, Scour, Hydraulic properties, Mathematical equations, Damage.

Efforts are made to lessen the vulnerability of bridges to flood damage. In the design phase of new bridges, hydraulics and scour should be duly considered in planning, site selection, and final design. In the matter of existing bridges, new and old, it is much more difficult to work out solutions. A program is needed to assess the vulnerability of every existing bridge and to contrive remedial measures to lessen vulnerability of those worth saving. Due to the vast number of bridges that would be involved as well as questions which remain in the hydrological aspects of the situation, such a program would be difficult to accomplish. The results of lab investigations of the scour at the toe of sill structures are given in the form of scour predicting equations for a vertical well and for a sloping sill. (Baker-IVI)
W85-06116

GUATEMALAN GREMLINS WREAK HAVOC UNDERGROUND,
D. Martin.
Tunnels and Tunnelling, Vol. 17, No. 1, p 14-19, January, 1985. 5 Fig.

Descriptors: *Guatemala, *Hydroelectric plants, *Quixal, *Tunnel construction, Geology, Tunnels, Tunneling, Lithology, Engineering geology, Construction equipment.

A 300 MW hydroelectric station has recently been completed in Guatemala. The tunneling contract included driving a 26 km long water supply tunnel from the reservoir at Pueblo Viejo to the power station at Quixal. This was in two parts: a 7600 m long tunnel from Pueblo Viejo to Agua Blanca and a 17,880 tunnel from Agua Blanca to the power plant, with the stipulation that 11,400 m of this be driven from Aqua Blanca. At Pueblo Viejo the work included building an intake structure, trash rake, inspection building and 55 m high valve tower. Extensive geological and hydrological investigations were carried out with special attention to areas of expected groundwater ingress in areas of high rainfall at Quixal and Pampur. However, samples were not studied under the microscope in the high rainfall area and insuffiencly detailed knowledge of the strata's mineralogy contributed to the problems that followed. The difficult faulted and folded karstic lithology brought extreme problems of water ingress and rockfalls causing the loss of a TBM at one stage. The inflow of water at up to 1000 liter/s was concentrated in confined spaces and created a difficult environment for many months. The construction work was finally completed in November 1982 in spite of additional rockfalls and colllapses in the tunnel and, of course, the water. The TBMs used were subject to the most difficult wear and strain and effects of water. The fullface TBM drive proved superior to the other methods used in these conditions. (Collier-IVI)
W85-06121

BALSAM MEADOW HYDRO PROJECT BEATS TIME AND HOLDS BUDGET,
D. Martin.
Tunnels and Tunnelling, Vol. 17, No. 3, p 19-22, March, 1985. 7 Fig.

Descriptors: *Tunnels, *Hydroelectric plants, *Construction, *Balsam Meadow, *California, Water resources development, Pumped storage.

The Balsam Meadow hydroelectric and pumped storage project will utilize most of the elevation head of water from Huntington Lake by transferring it to the lower Shaver Lake, located in southern California in the Sierra Nevada Mountains. Water will be diverted from an existing tunnel through a new 5868 ft long diversion tunnel into Balsam Meadow forebay, from where it will enter the power plant via a 282 ft upper power tunnel, a 959 ft vertical power shaft and a 1276 ft lower power tunnel. There is no classified support system for the upper power tunnel as a whole, and support will be provided only as required. Records have been set in raiseboring and some skilled shaft sinking is being carried out in the hard Sierra Granite to bring about the completion of this project. (Baker-IVI)
W85-06122

SMALL HYDRO SUPPLEMENTS IRRIGATION SCHEME,
Sacramento Municipal Utility District, CA.
G. Rummel, and B. Van Weele.
International Water Power and Dam Construction, Vol. 37, No. 4, p 19-25, April, 1985. 5 Fig.

Descriptors: *Water resources development, *Hydroelectric plants, *Irrigation programs, *California, Tunnels, Construction, Reservoirs, Small hydro, Dams.

A number of unusual engineering problems were encountered during the addition of a small scale hydro station to an existing irrigation scheme in California. One of these included driving a tunnel under an operating reservoir. The 6.8 MW Camp Far West hydraulic project was conceived as an addition to an existing dam and reservoir. The project is 40 miles northeast of Sacramento on the Bear River, with a catchment area of 285 sq miles and the headwaters of which originate at the lower eastern slope of the Sierra Nevada mountains. A feasibility study concluded that the existing dam and low level outlet works proved suitable for such a project and identified 12 project configurations which were possible. Preliminary designs and layouts were conducted during the planning, licensing, exploration, and design phases that greatly aided in the organized approach and sound development of the project. Detailed preliminary designs were performed to determine the foundation, elevation, and best type of cofferdam. (Baker-IVI)
W85-06128

CONSTRUCTION OF RIDING MILL WEIR,
D. J. Banks, I. Brooks, and W. M. Johnson.
Proceedings of the Institution of Civil Engineers, Vol. 77, p 195-216, February, 1985. 12 Fig, 1 Tab, 3 Ref, 1 Append.

Descriptors: *Weirs, *Construction, *Riding Mill Weir, *River Tyne, *England, Cofferdams, Piles, Costs, Sheet piles, Secant piles.

Construction of a concrete weir across the River Tyne is described, particularly the problems encountered and how they were overcome in driving sheet pile cofferdams and secant piles through densely packed large boulders. The weir was constructed as an integral part of the Kielder Water Scheme. It is required to provide an intake pond for Riding Mill Pumping Station which will transfer up to 1180000 cu m/day of water to the rivers Wear and Rees, to maintain minimum downstream flows, and to enable accurate low flow measurement of the Tyne. The proposed method had to be altered because of difficulties encountered in driving piles, which resulted in additional costs. There were areas where densely packed boulders in a matrix of sand could neither be split nor pushed aside. Boulders were removed by excavating in advance a trench up to about 2.5 m deep below river bed and backfilling this with compactable granular material. Then the sheet piles could be driven to the required depth. (Moore-IVI)
W85-06172

EMPINGHAM RESERVOIR PROJECT (RUTLAND WATER),
A. J. H. Winder, R. G. Cole, and G. E. Bowyer.
Proceedings of the Institution of Civil Engineers, Vol. 78, p 219-246, April, 1985. 13 Fig, 2 Tab, 29 Ref, 3 Append.

Descriptors: *Empingham Reservoir Project, *England, Legislation, Dam design, Construction, Tunnels, Pipelines, Reservoirs, Landscaping, Archaeology.

The need for the Empingham Reservoir Project arose from a steady increase in demand for water in the East Midlands (England) in the 1960s, accelerated by five planned special expansion areas. The paper briefly describes the promotion of the Parliamentary Act, the organization established to design and construct the project, the river intakes, the supply tunnels and pipelines, and the reservoir, together with some of the difficulties overcome. There are also comments on the landscaping and archaeological findings on the site. It is intended as a general introduction to the project, and to the other papers being presented. (Author's abstract)
W85-06173

8B. Hydraulics

HYDRAULICS OF THE LOWER POOL OF THE DUBOSSARY HYDROELECTRIC SCHEME,
K. S. Popova.
Hydrotechnical Construction, Vol. 18, No. 6, p 260-264, June, 1984. 3 Fig, 2 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 20-24, June, 1984.

Descriptors: *Hydroelectric plants, *Hydraulic properties, *Dubossary Hydroelecric Plant, *USSR, Dniester River, Reservoir operation, Turbulence, Hydraulic roughness, Dissipators, Spillways, Velocity, Dam design.

A study of the current regimes in nonuniform opening of dam gates and of erosion occurring the the lower pool is of great importance for designing new hydraulic structures and operating existing hydraulic structures. The operating experience at the Dubossary hydroelectric station on the Dniester River (USSR) is reviewed. The hydroelectric scheme is composed of an overflow dam with eight 13-m-wide bays with vertical lift gates, a powerhouse with four units combined with outlets above the spiral casings, and left-bank and right-bank earth dams. Since the first year of operation (1955), considerable problems have occurred due to erosion in the lower pool. The causes included insufficient dissipating and distributing action of the roughness ridges; the formation of additional turbulence due to a triangular dissipator located at the end of the rigid apron; nonuniform discharge along the spillway front; flow velocities greater than the design values; poor quality of early repair efforts; and, increase of the unit discharges on the apron of the dam compared with those calculated with closed bottom outlets of the hydroelectric station. (Keenan-IVI)
W85-05987

CHARACTERISTICS OF THE DRAG ON BAFFLE BLOCKS,
D. V. Shterenlikht, and A. B. Maslov.
Hydrotechnical Construction, Vol. 18, No. 6, p 265-268, December, 1984. 3 Fig, 13 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 24-26, June, 1984.

Descriptors: *Baffles, *Drag, *Hydraulics, Kinematics, Hydraulic structures, Hydraulic jump, Velocity, Cavitation, Design criteria.

The diversity of hydraulic phenomena in the lower pool of hydraulic structures, flow transition regimes, types of revetments and designs of dissipators in combination with the different geology and topography of the site of a hydroelectric scheme under construction considerably hamper the development of a general method of calculating and designing dissipators of the excess kinetic energy of the flow. Experimental investigations were performed to determine the relationship between the drag coefficients of baffle blocks and the kinematic characteristics of the flow and geometric parameters of baffle platforms. A laboratory-scale flume with a vertical lift gate and two rows of baffle blocks was employed to determine the required parameters. Three possible flow movement schemes on the horizontal baffle platform were examined. A change in the regimes of the fluid results in a change in the velocity characteristics of the flow, which in turn affects the reaction of the baffle blocks. The values of the drag coefficient increases as the baffle blocks approach the vena contracta. As the submergence of the baffle block increases, the drag coefficient of the block begins to decrease to a minimum value. In this case the hydraulic jump is in a limit state. A further increase in the natural depth and transition to a submerged hydraulic jump is accompanied by an insignificant increase in the values of the drag coefficient. A decrease in the relative height of the baffle block leads to an increase in the drag coefficient. An increase in the Froude number in the vena contracta leads to some decrease in the drag coefficient of the baffle block. The experimental results obtained can be used for calculating the geometry of the baffle plates of outlet works before the start of cavitation under two-dimensional conditions of their operation. (Shieh-IVI)
W85-05988

STAGE-FREQUENCY ANALYSIS AT A MAJOR RIVER JUNCTION,
Army Engineer District, St. Louis, MO.
For primary bibliographic entry see Field 2E.
W85-06035

HYDRODYNAMIC PRESSURES ACTING UPON HINGED-ARC GATES,
Wroclaw Technical Univ. (Poland). Inst. of Geotechnical Science.
For primary bibliographic entry see Field 8C.
W85-06036

8C. Hydraulic Machinery

HYDRODYNAMIC PRESSURES ACTING UPON HINGED-ARC GATES,
Wroclaw Technical Univ. (Poland). Inst. of Geotechnical Science.
R. Rogala, and J. Winter.
Journal of Hydraulic Engineering, Vol. 111, No. 4, p 585-599, April, 1985. 5 Fig, 3 Tab, 21 Ref, 2 Append.

Descriptors: *Hydrodynamics, *Hinged-arc gates, *Gates, Mathematical models, Mathematical equations, Pressure pulsation, Turbulence, Velocity.

The major load acting upon a hinged gate is hydrodynamic water pressure, the values of which must be determined if the structural members are to be dimensioned. A new method for calculating the mean value of the local hydrodynamic pressures acting upon a hinged gate and a mathematical model of pressure pulsation are developed. The mean hydrodynamic pressure at an optional point on the surface of a hinged gate is obtained by using the Bernoulli equation and model test data. The problem of the pulsation phenomenon of hydrodynamic pressure is solved by considering the random character of the process and by making measurements of pressure fluctuation. The experimental results and the characteristics of the processed signals obtained from the numerical analysis confirm theat the major cause of hydrodynamic pressure pulsations is flow-velocity pulsation due to turbulence. The pulsation frequency structure is not dependent on the position of the point examined on the gate. At any given point, the pulsation process varies only in its intensity, which increases along with the increase in flow intensity. A normalized power density spectrum equation, which characterized the frequency of the pressure pulsation, is derived. (Moore-IVI)
W85-06036

SMALL HYDRO PROGRESS IN MALAYSIA,
National Univ. of Malaysia, Bangi. Faculty of Economics.
For primary bibliographic entry see Field 6B.
W85-06129

DESIGNING GATES FOR SMALL HYDRO SCHEMES,
Watson and Noble Consulting Engineers, Auckland (New Zealand).
B. W. Leyland, G. R. Jessup, and S. R. Berry.
International Water Power and Dam Construction, Vol. 37, No. 4, p 33-37, April, 1985. 8 Fig, 3 Ref.

Descriptors: *Hydroelectric plants, *Design criteria, *Gates, *Small hydro, Penstocks, Intake gates, Spillways, Flip gates, Sluice gates, Engineering.

Small unattended hydro schemes pose special problems to the gate designer - how to design a gate that is cheap to build, easy to install and at the same time highly reliable. The loads on the gate must be calculated under all operating conditions. Lifting equipment should be designed to operate reliably under all operating conditions, with an adequate margin of safety. Gate seals can be a cause of difficulty. For intake gates, opening and closing times are dictated by the requirement of the turbine and any constraints imposed by the penstock. The level of reliability required for the gate operating system depends largely on the function of the gate. In all designs, tolerance to allow for correction of manufacturing errors should be included. Specifics are offered for penstock intake gates radial spillway gates, flap gates, sluice gates, automatic water level control gates, gate control and lifting gear, gate seals, installation and operation. While past experience should not be cast aside lightly, with the continuing development of materials and construction methods, an innovative approach can often be justified by the potentially large savings in cost. Care should be exercised to ensure that the resulting design is not over complicated. (Baker-IVI)
W85-06130

8D. Soil Mechanics

TENSILE AND COMPRESSIVE STRENGTH OF CLAYS FOR ASSESSING CRACKING CONDITIONS IN DAMS,
I. M. Vasilev.
Hydrotechnical Construction, Vol. 18, No. 6, p 241-247, June, 1984. 6 Fig, 1 Tab, 13 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 8-12, June, 1984.

Descriptors: *Clay, *Earth dams, *Soil strength, *Compressive strength, *Cracking, Mathematical equations, Soil physical properties, Strength, Linear deformation.

The traditional methods of checking a soil mass for cracking usually results in a considerable overestimation of the zones of possible discontinuity. Therefore, a need exists for a broader study of soil behavior under various tensile-compressive loading conditions. Experimental investigations were performed to establish the relationship expressing the theoretical construction of the total limit surface of strength, which is essential for the assessment of cracking conditions of a structure. Based on the values of the tensile and compressive strength of the homogeneous isotrophic soils as well as the relationships of the breaking linear deformations in tension and compression, approximate mathematical equations of the total limit surface of strength for any combinations of tensile-compressive loadings were derived. The applicability of the proposed mathematical equations for engineering problems was checked by experiments. (Shieh-IVI)
W85-05984

EXPERIENCE IN THE OPERATION OF HYDRAULIC STRUCTURES AND EQUIPMENT OF HYDROELECTRIC STATIONS: LEFT-BANK DAM OF THE BRATSK HYDROELECTRIC STATION,
Z. I. Solov'eva, and Yu. A. Zhebelev.
Hydrotechnical Construction, Vol. 18, No. 6, p 278-284, June, 1984. 5 Fig, 2 Tab, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 33-38, June, 1984.

Descriptors: *Earth dams, *Bratsk Hydroelectric Station, *USSR, Seepage, Drainage, Soil physical properties, Strength, Cracks, Shear, Stress, Soil consolidation.

The behavior of the left-bank earth dam of the Bratsk hydroelectric station was examined based on on-site observations and investigations performed during 1967-1983. The earth dam was constructed of gravel-sand filled with a loam core. The maximum height is 41 m, crest width 22 m. The gradients of the upstream slope and the downstream slope are 1:2.75 and 1:2 to 1:2.5, respectively. The upstream slope of the dam rests against a rock heel. Settlement of the dam due to consolidation of its soils has not ended, but is already noticeably decreasing. Settlement of the downstream slope is less intensive and more uniform. The seepage regime at the dam site meets the calculated condition, but differs from the design forecast because of the anisotropy of the sandstones which was not taken into account during modeling of the dam foundation. The drainage system at the left-bank dam is operating satisfactorily in conformity with the design criteria. Two tunnels were repaired in 1979 and are presently in good condition. No work as carried out on the other two tunnels during operation. The tunnels are in good condition. The data collected during 1967-1983 indicate that the left-bank dam of the Bratsk hydroelectric station is operating satisfactorily. The experimental results obtained indicated that the boundary, which separates the limit surface of strength into forms of fracture by extension and shear, can be approximated by a linear relation. Two conditions of limit equilibrium should be included in the calculation for extension, in order to assess the behavior of soil in the case of occurrence of tensile stresses; and for shear, in order to determine the depth of propagation of the extension crack. Once the size of the first crack and the corresponding state of stress and strain are established, the calculation cycle should be repeated for determination and consideration of the formation of the second, third, etc. cracks until a stable state of extension of the entire soil mass. (Shieh-IVI)
W85-05990

SETTLEMENT ANALYSIS OF EMBANKMENTS ON SOFT CLAYS,
Illinois Univ. at Urbana-Champaign.
G. Mesri, and Y. K. Choi.
Journal of Geotechnical Engineering, Vol. 111, No. 4, p 441-464, April, 1985. 17 Fig, 24 Ref.

Descriptors: *Clay, *Embankments, *Settlement, Compressibility, Soil mechanics, Interstitial water, Pressure dissipation, Computers, Consolidation, Permeability coefficient.

Highly realistic analysis of the consolidation of soft clays is possible within the framework of the traditional concepts of soil mechanics. A practical method is described for predicting the magnitude and rate of settlement and pore water pressure dissipation. Detailed interpretation and evaluation

of the consolidation properties of soft clays, including the compressibility parameters, preconsolidation pressure and coefficient of permeability are presented. These properties can be determined from the standard oedometer test with direct permeability measurements. Computer procedure ILLICON, using multi-layer analysis, includes any variation of consolidation parameters with depth. The proposed method for evaluating the consolidation parameters, and settlement and pore water pressure analyses is illustrated using case histories of two test fills on soft clays. Excellent agreement is obtained between the computed behavior and field observations. (Author's abstract)
W85-06023

INVESTIGATION OF MOISTURE-INDUCED VARIATION IN SUBGRADE MODULUS BY CROSS-CORRELATION METHOD,
S. S. Bandyopadhyay, and J. A. Frantzen.
Transportation Research Record, Vol. 945, p 10-15, 1984. 8 Fig, 1 Tab, 21 Ref.

Descriptors: *Soil water, *Construction, *Subgrade modulus, Soil properties, Soil mechanics, Highways, Precipitation, Rainfall.

The change in moisture content of subgrade soils and its resultant effects on structural pavement performance are of interest to many highway engineers. One of the primary sources of moisture in the subgrade is water from precipitation. The feasibility of statistically relating the variation in subgrade modulus with the corresponding time history of precipitation was investigated. The study showed that the subgrade modulus is directly affected by precipitation. The time required for the subgrade to reach its weakest state after a rainfall is quite long; depending on local factors, it might be as long as 3 weeks. At the 95 and 99% confidence levels a correlation is found to exist between the two time series - precipitation history and corresponding variation in subgrade modulus. (Baker-IVI)
W85-06063

8E. Rock Mechanics and Geology

RELIABILITY OF ROCK FOUNDATIONS OF CONCRETE DAMS AND SOME RECOMMENDATIONS ON THEIR ASSESSMENT,
E. G. Gaziev, and E. S. Kalustyan.
Hydrotechnical Construction, Vol. 18, No. 6, p 274-277, June, 1984. 3 Fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, p 30-33, June, 1984.

Descriptors: *Dam foundations, *Foundation failure, *Concrete dams, Flood damage, Reservoir operation, Earthquakes, Shear strength, Erodibility.

The operating reliability of a dam, including the reliability of its foundation at the contact with the dam and at depth, can be evaluated on the basis of criteria characterizing the final state of the structure (failure or damage) as a result of its interaction with the environment. Based on the historical record of rock foundations of concrete dams the probability of failure is 0.3% and the probability of damage is 2.7%. Combining failures with damage, 78% of such incidents occur during filling of the reservoir, 16% as a result of floods, 2% related to earthquakes and 4% as a result of other forces. These incidences were due to increases in permeability of the foundation (57%), nonuniform deformability of the foundation (22%), disturbance of the shear strength of the rock in the foundation (9%) and erodibility of the rocks of the lower pool (12%). (Keenan-IVI)
W85-05989

UNDERGROUND DESIGN AT ANDEKALEKA HYDROELECTRIC DEVELOPMENT,
Montreal Engineering Co. Ltd. (Quebec).
For primary bibliographic entry see Field 8A.
W85-06043

8F. Concrete

ATTRITION RATES OF SOIL-CEMENT SUBJECTED TO WATER JETS,
L. L. Litton, and R. A. Lohnes.
Transportation Research Record, Vol. 941, p 18-23, 1984. 7 Fig, 4 Tab, 2 Ref.

Descriptors: *Cement, *Erosion control, *Soil-cement, Channel improvement, Stream stabilization, Alluvium, Strength, Loess, Freezing, Velocity.

Laboratory erosion tests on cement-stabilized alluvium and alluvium-sand mixtures from western Iowa produce attrition rates that decrease with time at a constant water velocity. In laboratory tests, specimens lost 54-97% of their total weight loss during the first 30 min of a 5 hr test at a constant water velocity. Apparently, the basic soil cement erosion resistance is greater than any erosive force applied to the laboratory test specimens thus far. The material lost under the erosive forces was presumably that which deteriorated during the freezing and thawing cycles, and the reduction in the rate of erosion was a consequence of reaching material that was weathered to a lesser degree. As anticipated, the attrition rate decreased with increasing relative durability of the soil-cement. Although the results of the laboratory tests cannot be used to predict directly the attrition rate of soil cement used in a stream channel grade-stabilization structure, the general time-loss behavior is thought to be valid. The implications of the laboratory tests as they relate to field implementation are: soil cement composed of loess derived alluvium and sand with alluvium will withstand high water velocities. At any given flow rate, the attrition rate of the soil-cement will decrease rapidly; therefore, the soil-cement will reach a stable configuration relatively early in the flow event and subsequent material loss will be minimal. (Baker-IVI)
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